Plural reference and exception tolerance in the semantics of habituals

Omar Agha
University of Connecticut
agha@nyu.edu

Abstract Habitual sentences in English have sometimes been analyzed using a silent quantifier over times or events. Though the silent quantifier approach works in simple cases, it does not adequately account for the behavior of habitual readings under negation. Negated habitual sentences have a reading that is stronger than expected. This pattern has been discussed in previous work on habituals (Ferreira 2005) and generics (Carlson 2008), but a detailed formal analysis is still forthcoming.

In this paper, I argue that habitual sentences involve reference to a plurality of times, and that their strong readings result from a trivalent semantics, parallel to the homogeneity effects observed with plural definites. The formal analysis of these facts uses ideas from Ferreira (2005) and Križ (2015). The underlying plural reference also explains why and when habituals tolerate exceptions, parallel to non-maximality effects with plurals (Malamud 2012, Križ 2015).

Keywords: homogeneity, non-maximality, tense, aspect, definites, adverbs, quantification, Questions Under Discussion

1 Introduction

Negated habitual sentences such as (1a) have a negative universal reading. The first clause of (1a) seems to entail that Connie *never* calls her mother on a Saturday. This explains the infelicity (#) of the second clause, which contradicts the negative universal entailment. Overt quantificational adverbs such as *always* in (1b) and *every Saturday* in (1c) render the followup acceptable.

(1) a. Connie doesn't call her mother on Saturday, # only every other Saturday.

b. Connie doesn't **always** call her mother on Saturday, ✓ only every other Saturday.

c. Connie doesn't call her mother **every** Saturday, ✓ only every other Saturday.

This pattern resembles the well-known *homogeneity effects* observed with plural definites. While (2a) only has a negative universal reading, (2b) has a global non-universal reading (easily explained by low scope of *all* under negation).

(2) a. I didn't eat the cupcakes, # but I ate half of them.

b. I didn't eat **all** the cupcakes, ✓ but I ate half of them.

Homogeneity effects were first analyzed by Fodor (1970), and Löbner (1985), who assume that plural definite descriptions carry a homogeneity presupposition. These analyses put homogeneity on a par with the gaps that result from presupposition failure (von Fintel 1997, Gajewski 2005, Ferreira 2005). However, a more recent wave of analyses (Malamud 2012, Magri 2014, Križ 2015) have attempted to relate homogeneity effects to exception-tolerance, significantly expanding the empirical scope and generality of the phenomenon.

I propose that Križ's (2015) re-framing of the problem of homogeneity, and in particular the link between homogeneity and non-maximality, paves the way for an analysis of habitual readings that does not rely on any specialized silent aspectual operators. On this account, the properties of habitual sentences like (1a) arise from the interaction of independently-needed mechanisms, and not from the presence of a silent quantifier.

1.1 Homogeneity

I assume that all predicates of times are *homogeneous* in the sense of Križ (2015). Križ initially applies homogeneity to predicates of individuals: A plurality in the extension of a predicate $\lambda x.P(x)$ must not overlap with any plurality in $\lambda x.\neg P(x)$. Thus, (3a) means that all of the windows are open, and (3b) means that none of the windows are open.[1]

(3) a. The windows are open. $*\textbf{open}(\bigoplus \textbf{window})$

b. The windows are not open. $\neg * \textbf{open}(\bigoplus \textbf{window})$

The extension to predicates of times is entirely natural: When a sentence S is true of some plurality of time intervals t, it cannot be false of any plurality s that overlaps with t. From this, it follows that (4a) means that Riley swims on every morning, and (4b) means that Riley doesn't swim on any morning.

1 In (3) and (4), I do not indicate the contextual domain restrictions, but I assume that the domain restrictions are identical across the (a) and (b) examples. See Križ (2015: 74-45) for discussion on domain restrictions. The * operator closes the extension of a predicate under sums.

(4) a. Riley swims in the morning. $*\mathbf{swim}(\bigoplus\mathbf{morning})(\mathbf{riley})$

b. Riley doesn't swim in the morning. $\neg*\mathbf{swim}(\bigoplus\mathbf{morning})(\mathbf{riley})$

Homogeneity effects are observed in both unrestricted temporal anaphora as in (5) and explicit restriction by frame adverbials as in (4). Here, t is a free variable that points to a salient time interval.

(5) a. Riley swims. $*\mathbf{swim}(t)(\mathbf{riley})$

b. Riley doesn't swim. $\neg*\mathbf{swim}(t)(\mathbf{riley})$

I assume the domain of time intervals is nonatomic (von Stechow 2009): Every time interval is a sum of time intervals, so homogeneity can be applied to all predicates of times, regardless of the properties of their temporal arguments. Time pronouns are never restricted to atomic referents. Thus, any tensed sentence S potentially shows homogeneity effects, since time intervals in the extension of S overlap with intervals that are outside the extension of S.

1.2 Non-maximality

The theory that habituals involve plural reference also explains their exception-tolerance. Malamud (2012) and Križ (2015) analyze examples in which speakers produce and accept plural predications of the form $P(x)$, even in contexts where only some parts of the plurality x satisfy the predicate P. This phenomenon is called *non-maximality*. For example, consider the sentence (6) in two different contexts.

(6) Riley drinks coffee in the morning.

(7) Question Under Discussion *favors* a non-maximal reading
Context: Riley drinks coffee only a few mornings a week, but never in the afternoon.
Question Under Discussion: *Does Riley drink coffee in the afternoon?*
Riley drinks coffee in the morning.

(8) Question Under Discussion *blocks* a non-maximal reading
Context: Riley drinks coffee only a few mornings a week, but never in the afternoon.
Question Under Discussion: *Does Riley drink coffee every day?*
Riley drinks coffee in the morning.

The non-maximal use is in (7), where the exact proportion of mornings where Riley drinks coffee is not relevant. In (8), where it is relevant, the habitual is no longer felicitous. Analyses of habituals that stipulate a silent adverbial quantifier do not explain temporal homogeneity and non-maximality.[2]

1.3 The proposal

The idea that habitual sentences involve plural reference and homogeneity effects is due to Ferreira (2005: 81-90). Since Ferreira's original proposal, Križ (2015) has provided the field with a general theory of homogeneity effects. Križ's theory has two properties that are crucial for analyzing habitual sentences. First, it is not specific to either definite descriptions or individuals, allowing a natural extension to time pronouns and temporal adverbials. Second, it predicts that homogeneity and exception tolerance are linked, via the theory of non-maximality. This second property is most important for capturing the novel data in Section 3.

The theory is based on the following informal generalization, to be formalized later on. Note that in the present work I use the term **indeterminate** instead of undefined, to keep homogeneity effects separate from presupposition failure.

(9) **Homogeneity Generalization** Križ 2015: 7
No individual in the positive extension of a [homogeneous] predicate [can] overlap with an individual in its negative extension.

The term *individual* above is intended to apply to pluralities as well as atomic individuals. Consider the sentence below, which shows the application of a homogenous predicate to a plural argument, resulting in an indeterminate truth value.[3] Throughout the paper, I use # to indicate infelicity in a given context.

(10) QUD: How many people jumped in the lake?
Context: Six boys are playing by the lake. Five of them jump in.
The boys jumped in.

If it is understood that *the boys* refers to the six boys in our scenario, then we predict that the truth value of (10) will be indeterminate. This is because the set of five boys who jumped overlaps with the denotation of *the boys*, but is not equal to it.

1.4 Roadmap

The structure of the paper is as follows. In Section 2, I introduce the systematic parallels between definite plurals and habitual sentences. In Section 3, I provide

2 See Deo (2009) for other arguments against Q-adverb approaches to habituals.
3 Löbner (1985: 286:(12)) also notes that predication involving non-plural individuals requires homogeneity once we consider their parts. For example, he observes that *John is dirty.* is true if John is totally dirty, false if John is totally clean, but intermediate if John is only partly dirty

novel arguments that exception-tolerance in habituals depends on the Question Under Discussion (QUD) (Roberts 2012). Thus, Križ's QUD-based analysis of non-maximality is the theory that is best equipped to deal with exception-tolerance in the temporal domain. In Section 4 I compare the present approach to previous attempts to derive the exception tolerance of habituals. In Section 5, I discuss some formal detail on temporal adverbials, including matching functions. In Section 6 I conclude.

The Appendix contains a fully compositional grammar fragment. The ideas in the compositional fragment are based heavily on the trivalent type theory apparatus in Križ (2015: Chapter 2).

2 Key data: bare habituals

In this section, I compare quantified habitual sentences with **bare habituals**—habituals without overt quantifiers. While quantified habituals are ambiguous under negation, bare habituals are not. Following Ferreira (2005), I argue that the lack of ambiguity in negated bare habituals is due to a homogeneity effect, parallel to those found with plural definite descriptions of individuals under negation.

In Section 2.1, I distinguish between bare habituals, which display homogeneity effects, and quantified habituals, which do not. In Section 2.2, I present novel data and use them to argue that habitual sentences show homogeneity effects, and that these homogeneity effects are entirely parallel to those that Križ observes with plural definites.

2.1 Classes of habitual sentences

Habitual sentences can be divided into two broad classes: bare habituals like (11a) and sentences involving adverbial quantifiers like (11b). I adopt the terminology *bare* to mean *non-quantificational*, following Ferreira (2005).

(11) a. Semantics Group meets (on) Friday mornings. (bare habitual)

b. Semantics Group meets (on) every Friday morning. (quantified habitual)

One might object that *(on) Friday mornings* functions as an adverbial quantifier, but when we add negation the two examples come apart, as we can see in (12) and (1).[4]

(12) a. SG doesn't meet on Friday mornings, # only every other Friday.

b. SG doesn't meet every Friday morning, only every other Friday.

4 As before, # indicates infelicity in context, but in (12) and (1) there will be infelicity in *any* context, due to the contradiction.

These facts are not just a consequence of the explicit temporal modifiers like *on Friday mornings*. It turns out that nothing changes when we consider bare habituals with no temporal modifiers. The pattern of judgments that we observe with the temporal PP *on Friday mornings* in (11a) is exactly the same as the pattern in (13).

(13) a. #Anya doesn't swim, but she does sometimes.

b. Anya doesn't always swim, but she does sometimes.

Quantificational adverbials (Q-adverbs) like *always* and *every Friday*, on the other hand, produce scope ambiguities under negation.[5]

Once these facts are considered together, we can safely separate out at least two kinds of temporal modifiers: those that, like quantifiers, enter into scopal ambiguities with negation, and those that do not.

2.2 Homogeneity properties of habituals

In this section, I look at several patterns of judgments that function as diagnostics for homogeneity. In each case, the key patterns that Križ (2015) found for plural definites can be replicated for habitual sentences.

2.2.1 The *well*-test

There are certain situations in which it is not appropriate to either affirm or deny a habitual sentence. According to the homogeneity theory, this is because the habitual sentence is neither true nor false in the context. For plural definites, Križ uses responses with *well* as a diagnostic for indeterminate truth values. I adapt this test to bare habituals in (16). To conclude that sentence (16A) has an indeterminate truth

5 Sentence-final Q-adverbs can be scopally ambiguous, as in (14a). When Q-adverbs are topicalized, they generally take wide scope, as in (14b).

(14) a. Ben doesn't swim every morning. But he does swim some mornings.

b. Every morning, Ben doesn't swim. # But he does swim some mornings.

In contrast, bare habituals with non-quantificational temporal adverbials have the same reading whether the adverbial is topicalized or not, though there may be some information-structural differences. Neither (15a) nor (15b) can have a narrow scope universal reading.

(15) a. Ben doesn't swim when it's morning. # But he does swim some mornings.

b. When it's morning, Ben doesn't swim. # But he does swim some mornings.

value, the *well*-response must be not only available, but preferred to a *no*-response. The mere availability of a *well*-response is not sufficient to establish that the sentence being responded to is indeterminate.

(16) *Context: Albert has a habit of running in the morning, especially when the weather is good. Today, he had an early meeting, so he didn't make it.*
A: When it's sunny, Albert runs in the morning.
B: Well, he didn't today.
B': ?? No, he didn't today.

(17) *Context: Annie, Bonnie, and Connie are occasionally late to school. Bonnie's attendance is the best, but even she comes late sometimes.*
Annie: Bonnie comes to school on time.
Connie: Well, most of the time.
Connie': ?? No, most of the time.

Plural definites behave the same way. When the plurality denoted by the definite is not in the extension of the predicate, but overlaps with a plurality that is in the extension, the *well*-response is preferred.

(18) *Context: Half of the professors smiled.* Križ 2015: 75:(14)
A: The professors smiled.
B: Well, half of them.
B": ?? No, half of them.

(19) *Context: In a large graduating class, most of the kids join together to sing a song.* (my example)
A: The kids sang.
B: Well, most of them did.
B': ?? No, most of them did.

While the *no*-responses in all these examples are dispreferred, they are not impossible. I suggest that this variability in judgments results from subtle shifts in the Question Under Discussion (Roberts 2012). As discourse participants shape the flow of information according to their conversational goals, they constantly re-negotiate the QUD using both explicit and implicit means. This fluctuation in the QUD means that *no*-responses occasionally show up as responses to indeterminate sentences. In those cases, they act as a signal that speakers intend to make finer distinctions than are relevant to the current QUD. I return to this subject in Section 3, where I discuss the role of the QUD and its relation to exception-tolerance.

2.2.2 *All*, *always*, and distributive quantifiers

Adding *always* or a distributive quantifier over times removes homogeneity from habitual sentences. To see this, compare the negated bare habituals in (20) with the negated quantified habituals in (21) and (22). The quantified sentences have far weaker truth conditions than (20). In fact, they typically come with implicatures that there are relevant occasions where Ben *does* bite his fingernails. In other words (21) and (22) are not only weaker, but usually implicate that (20) is not true.

(20) Ben doesn't bite his fingernails.
⇒ Ben never bites his fingernails.

(21) Ben doesn't always bite his fingernails.
⇒ At some of the relevant times, Ben does not bite his fingernails.

(22) Ben doesn't bite his fingernails every day.
⇒ Some days, Ben does not bite his fingernails.

Križ notices exactly the same pattern when examples with plural definites are compared to examples with *all* or distributive quantifiers over individuals.

(23) The kids didn't sing. ⇒ None of the kids sang.

(24) All the kids didn't sing. ⇒ Not every kid sang.

Sentence (24) has a reading on which it is possible that some but not all of the kids sang, unlike (23).

2.2.3 Unmentionability of exceptions

Habituals are known to be exception-tolerant in certain contexts (Carlson 2012, Deo 2009). This mirrors the exception tolerance of plural definites. The full theory behind this is explained in Section 3. For now, I note that even when exceptions are possible, it is infelicitious to mention them in a followup.

(25) *Unmentionability of exceptions in habituals*

a. # Ben doesn't bite his fingernails, he only does it once a month.

b. # Ben doesn't bite his fingernails, he only does it after stressful meetings.

This is exactly parallel to the situation with plural definites, where exceptions are occasionally tolerated, but not mentioned explicitly without further explanation.

(26) *Unmentionability of exceptions in plural definites* Kroch 1974: 191:(5a,7a)

a. # Although the men in this room are angry, one of them isn't.

b. # Although the Jones's horses died in the barn fire, some of them didn't.

The source of this restriction is that whether a habitual tolerates exceptions depends on the relevance of those exceptions in the given context. In particular, the Question Under Discussion might draw a sharp boundary between mixed scenarios and homogeneous scenarios (in which case exceptions are not tolerated) or it might group some mixed scenarios together with some homogeneous scenarios. In the second case, those exceptions are irrelevant to the QUD, so mentioning them explicitly as in (26) would violate the Maxim of Relevance. We will return to these points in detail.

In summary, plural definites and habituals pattern together with respect to three diagnostics: Strong readings under negation, the *well*-test, and the unmentionability of exceptions.

3 Non-maximality in habituals

In this section, I present a new generalization about habitual sentences, namely that they tolerate exceptions only when those exceptions do not matter for resolving the QUD. Previous accounts of the exception-tolerance of habituals do not account for this fact, as I discuss in Section 4.

I pursue an analysis on which the exception-tolerance of habituals is a species of *non-maximality*. According to the theory laid out in Križ (2015), in any area of the grammar in which we observe homogeneity effects, we should also expect exception-tolerance. This is because sentences with an indeterminate truth value can still be accepted as *true enough* under certain circumstances (to be defined shortly).

According to the theory of non-maximality, speakers are not required to say only sentences which they believe to be true, as in Grice's (1975) Maxim of Quality. Rather, they have a weaker responsibility to only say what they believe is true enough in the current context.

(27) **(Weak) Maxim of Quality** Križ (2016)

Say only sentences which you believe to be true enough.

Informally, a sentence is *true enough* if the worlds in which it is true are not distinguished from the evaluation world by the Question Under Discussion.[6] This will be fully formalized in (38) below.

6 Križ uses the term *Current Issue* rather than *Question Under Discussion* to name this contextual parameter, which is formally a partition over the set of possible worlds. There are distinctions between the two, but I use the QUD here for the sake of clarity.

3.1 Non-maximality with plural definites

Consider the indeterminate sentence in (28). Križ observes that this sentence is accepted as true enough in a mixed context as long as the exceptions do not matter for the Question Under Discussion.

(28) Non-maximal plural definites — Križ 2015: 73
Context: Professor Smith never smiles after talks. After Sue's talk, every professor smiled but Smith, who wore a neutral expression.
The professors smiled. $[\star \rightsquigarrow 1]$

In this case, we can take the Question Under Discussion to be something like (29).

(29) Was Sue's talk well-received?

If we know that Smith never smiles after talks, then we might think that Smith doesn't smile after even the very best talks. Thus, the world where every professor but Smith smiles will still count as a world where Sue's talk is well received. The Question Under Discussion will not distinguish this mixed world from the homogeneous worlds where all the professors smile.

Varying the QUD changes the acceptability of responses to plural definites. For example, in (30), the QUD is whether the discourse participants are being too loud. In this case, the fact that some of the townspeople might be awake at 2AM is not relevant to the QUD. What matters is that making noise is unacceptable as long as *enough* people are asleep.

(30) *Context: It's 2AM in a small town.*
A: Don't make noise, the townspeople are asleep! $[\star \rightsquigarrow 1]$
B_{well}: Well, we're awake. $[1]$
B_{no}: #No, we're awake. $[\star \rightsquigarrow 0]$

Because A's assertion is true enough, the denial in B_{no} is false enough, violating the Weak Maxim of Quality (27).

We can contrast this with an example based on Lasersohn (1999: 523) cited by Križ (2015: 72-73). In this example, the Question Under Discussion is whether the experiment can begin, so there will be no mixed worlds in the same cell as the homogeneous world where every participant is asleep. Thus, A's assertion is false enough, and the denial is true enough.

(31) *Context: A sleep study. The study can only begin once the participants are asleep. One person is still tossing and turning.*

A: #The participants are asleep. [$\star \rightsquigarrow 0$]
B_{well}: Well, one person is still awake. [1]
B_{no}: No, one person is still awake. [$\star \rightsquigarrow 1$]

As we will see, habitual sentences are sensitive to the Question Under Discussion in precisely the same way.

3.2 Non-maximality in habituals

In this section I present examples of habitual sentences in contexts where exceptions are tolerated. In each pair of examples, the Question Under Discussion is manipulated in various ways, and it turns out that the interpretation of the habitual is exception-tolerant whenever the QUD is not sensitive to small exceptions.

In the first example in (32), Annie's assertion is perfectly natural. Intuitively, this is because the discourse participants' attendance is very bad, and they are comparing themselves to Bonnie, whose attendance is quite a bit better.

(32) *Context: Annie and Connie are late to school almost every day, but Bonnie's attendance is generally good. Bonnie comes to school on time about on most days, but a few times a month she is late. Annie says to Connie:*
Annie: Bonnie comes to school on time. [$\star \rightsquigarrow 1$]

In this context, I assume that the Question Under Discussion is (33). Recall that Annie's assertion is strictly true only in the worlds where Bonnie is always on time. What is crucial about (33) is that the worlds where Bonnie is always on time are in the same alternative as the actual world, where Bonnie's attendance is imperfect, but still generally good.

(33) Whose attendance is generally good?
(Contains the alternative: Bonnie's attendance is generally good.)

Further evidence is available when we compare responses with *well* to denials with *no*. When we compare Connie's *well*-response to the *no*-denial in (34), the denial is degraded.[7]

7 The reason why the *no*-response is degraded, but not altogether impossible, is that in real discourse, there is an outside chance that the Question Under Discussion can shift as discourse participants renegotiate their conversational goals. At any point in time, one or both of the discourse participants could decide to impose a more exacting QUD, according to which the worlds where Bonnie is usually on time and the worlds where Bonnie is always on time will not occupy the same cell. The availability of silent QUD-shifting is a challenge for all theories that crucially rely on the QUD, and a full resolution of this problem is outside the scope of this study.

(34) *Context: Same as (32).*
Annie: Bonnie comes to school on time. [$\star \rightsquigarrow 1$]
Connie: Well, she does most of the time. [1]
Connie': ??No, but she does most of the time. [$\star \rightsquigarrow 0$]

When we impose a more stringent QUD, as in (35), small exceptions (occasional lateness) become important. In (35), all attendance is being logged on a regular basis. In this kind of context, the *no*-response is felicitous.

(35) *Context: Stickers are being given out for perfect attendance. Bonnie comes to school on time about on most days, but a few times a month she is late.*
Annie: Bonnie comes to school on time. [$\star \rightsquigarrow 0$]
Connie: No, but she does most of the time. [$\star \rightsquigarrow 1$]

In this case, the Question Under Discussion is (36). Connie's denial is true enough in this context because the mixed worlds (where Bonnie's attendance is imperfect) are still worlds where she does not get a sticker, just like the worlds where Bonnie never comes to school on time.

(36) Who gets a sticker?
(Contains the alternative: Bonnie gets a sticker.)

Note that the *well*-response is also felicitous in the strict context. This is expected given the parallel facts with non-maximality in plural definites—recall the sleep study scenario in (31).

For the last example, let us consider a short dialogue in which discourse participants have different views on the Question Under Discussion, and produce apparently incompatible habitual sentences based on their divergent views. In (37), the Question Under Discussion is whether Connie is healthy. By committing to the proposition *Connie smokes* when in fact Connie only smokes very rarely, Annie reveals that her version of the Question Under Discussion divides worlds in which Connie never smokes from the actual world, in which she smokes rarely. Bonnie's response reveals that her version of the Question Under Discussion groups these worlds together.[8]

(37) *Context: Bonnie is asking Annie about Connie's health. Bonnie thinks occasional smoking is not a significant health issue, but Annie thinks that it is.*
Annie: Connie smokes.
Bonnie: How often?

8 One might object that this example shows that *smokes* is a vague predicate. I address this objection is Section 4.

Annie: Well, only once a year, at New Years.
Bonnie: Oh, so she doesn't smoke then.

Interestingly, these are two different versions of the same Question Under Discussion (*Is Connie healthy?*), but speakers behave differently depending what they think the actual content of the issue is. The result is a dialogue that is entirely plausible, but difficult to explain unless bare habitual sentences are sensitive to subtle shifts in the Question Under Discussion.

3.3 Analysis of non-maximality

I assume a trivalent semantics and adopt Križ's notation for the positive extension $[\![S]\!]^+$ (the set of all worlds that make S true) and the negative extension $[\![S]\!]^-$ (the set of all worlds that make S false). The worlds at which S is indeterminate will be in neither set. As we stated before, a sentence whose truth value is indeterminate may still be *true enough* for the purposes of the conversation. Here, we make this notion formally precise.

(38) **Sufficient Truth** Križ (2016)
We write $\simeq_I$ for the equivalence relation that holds of two worlds u, v iff u and v are in the same cell of an issue I. A sentence S is **true enough** in world w with respect to I iff there is some world w' such that $w' \in [\![S]\!]^+$ (S is true in w') and $w \simeq_I w'$.

In addition, discourse participants make their utterances relevant to the discussion by *addressing the (Current) Issue*.

(39) **Addressing an Issue** Križ (2016)
A sentence S may be used to address an issue I only if there is no cell $i \in I$ such that i overlaps with both the positive and the negative extension of S, i.e. S is true in some worlds in i and false in others.

In other words, no possible answer to I may include both worlds where S is true and worlds where S is false.

Consider the sentence (40). In my dissertation, I give a compositional semantics that derives logical translations for these sentences with the desired truth conditions. Here, I give informal paraphrases to simplify the presentation.

(40) On school days, Bonnie comes in on time.
$[\![(40)]\!]^+ = \{w \in D_s \mid$ Bonnie is on time on *all* school days in w$\}$
$[\![(40)]\!]^- = \{w \in D_s \mid$ Bonnie is on time on *no* school days in w$\}$

Suppose w^1 is a world where Bonnie is unfailingly on time, w^0 is a world where Bonnie is unfailingly late, and $w^\star$ is a world where Bonnie is mostly on time, but occasionally late. The world w^1 will be in the positive extension $[\![(40)]\!]^+$, w^0 will be in the negative extension $[\![(40)]\!]^-$, and $w^\star$ will be in neither.

Consider the two possible Question Under Discussions below. Since they are polar questions, each Issue I is modeled as a set of two cells, i_1 (the positive answer) and i_0 (the negative answer). The lax Question Under Discussion I^{lax} (41a) is such that the positive answer contains both w^1 and $w^\star$, while for the strict Question Under Discussion I^{strict}, the positive answer only contains w^1 (out of the three worlds considered).

(41) a. Is Bonnie generally on time?
$I^{\text{lax}} = \{i_1^{\text{lax}}, i_0^{\text{lax}}\}$ $\quad w^\star, w^1 \in i_1^{\text{lax}}$ $\quad w^0 \in i_0^{\text{lax}}$

b. Does Bonnie get a sticker for perfect attendance?
$I^{\text{strict}} = \{i_1^{\text{strict}}, i_0^{\text{strict}}\}$ $\quad w^1 \in i_1^{\text{strict}}$ $\quad w^\star, w^0 \in i_0^{\text{strict}}$

Whenever the actual world is a mixed world like $w^\star$, I predict that the habitual sentence (40) will be true enough when the Question Under Discussion is lax (41a), and will be false enough when the Question Under Discussion is strict (41b). This is precisely the situation in examples (32-35) from the previous section, where the context ensures that the actual world is a mixed world.

4 Comparison to previous work

The idea that bare habituals involve plural predication of events has been around since at least Ferreira (2005), but the present work gives the first account of exception-tolerance in habitual sentences that captures its context-sensitivity. The non-maximality account has the distinct advantage that its predictions can be tested by manipulating the Question Under Discussion. What we find is that bare habituals are not exception-tolerant across the board, but only when their exceptions are not relevant to resolving the Question Under Discussion.

In this section I discuss previous approaches to exception tolerance in habitual sentences. In many cases, authors have noted that habituals tolerate exceptions, but none have systematically connected these exceptions to particular contextual parameters such as the Question Under Discussion. As a result, they make no predictions about contexts in which exceptions matter, which I have called the strict contexts.

4.1 Ferreira (2005)

Ferreira (2005) first proposed that bare habituals should be analyzed using plural event predication. He uses a version of event semantics in which events are atomic. This allows him to analyze *when*-clauses in sentences like (42) using the semantics in (43).

(42) When John writes a romantic song, he goes to the Irish pub. Ferreira 2005: 63:(87)

The meaning for *when John writes a song* is true of those pluralities whose proper parts satisfy the event description $\lambda e.\exists y[\textbf{song}(y) \wedge \textbf{write}(e, j, y)]$.

(43) Ferreira's analysis of distributive *when*-clauses
$[\![\text{when John writes a song}]\!] = \lambda E.\forall e[e < E \rightarrow \exists y[\textbf{song}(y) \wedge \textbf{write}(e, j, y)]]$
(True of a plurality of events E if every proper part of e is a John-writes-a-song event.)

Ferreira then applies a definite determiner to (43) before composing it with the main clause. The result is that (42) is true if the unique plurality of events whose proper parts are songwriting-events is plurality of pub-going events. If such a definite plurality exists, this gloss does not seem to tolerate any exceptions.

One difference between the present work and Ferreira's analysis is that Ferreira focuses on the modal properties of habitual sentences, which he sees as parallel to the modal properties of the progressive (Dowty 1979, Landman 1992, Portner 1998). One of Ferreira's primary goals is to account for the common modal imperfective core of habitual and progressive readings across languages. Ferreira (2005: 57-59) suggests that the exception-tolerance of habitual sentences can be explained via the modal semantics, but once the modal semantics is introduced in Chapter 4, there is no explicit discussion of exceptions. Thus, Ferreira's predictions about exceptions are not clear, and to the extent that exceptions can be accommodated, there is no expectation that they should depend on the Question Under Discussion.

4.2 Deo (2009)

Deo (2009), like Ferreira, aims to account for the shared modal properties of imperfective verbs, whether read progressively or habitually. Deo (2009: 483-484) argues against an event-quantification analysis, observing that even explicitly domain-restricted habituals like (42) are exception-tolerant. She concludes that a quantificational account cannot easily build in exception-tolerance via implicit quantifier domain restriction.

Deo's habitual semantics has two components. First, she implements a Dowty-style modal semantics using a branching-time framework. Second, she assumes that the imperfective aspect quantifies over a partition of the restrictor-times (e.g. the *when*-clause times in (42), or a contextually-provided temporal restriction). Thus, (42) roughly means that the song-writing times are contained in a possible history which is regularly partitioned into intervals, each of which includes a pub-going time. Deo (2009: 493-494) ultimately explains the exception-tolerance of habituals using the flexibility introduced by the contextually-specified partition. For example, the partition in example (42) could group together certain song-writing events and separate others, leading to an imperfect match between song-writings and pub-goings.

Though this solution is extremely interesting in its own right, and is backed up by a sophisticated and precise analysis, it does not quite fit the novel data I present in Section 3. First, Deo requires that the partition that provides the modal quantifier domain must be *regular*. In other words, the intervals in the partition must be of equal measure. Assuming each song-writing takes around the same amount of time, Deo derives a result for (42) where either every song-writing corresponds to a pub-going (no exceptions), or every n song-writings correspond to a pub-going, for some context-dependent number n (regularly-grouped exceptions). The size of the partition determines which of these two kinds of readings is actually predicted. However, it seems that exceptions to habitual sentences can be quite irregular in general. For example, Bonnie's absences in Section 3 example (32) could be spaced out or clustered together. Moreover, the predicted reading, where every n song-writings correspond to a pub-going, does not seem like a natural reading of (42).

Second, and most importantly, on Deo's analysis there is no expectation that exception-tolerance should vary with the Question Under Discussion. It may be possible to relate the Question Under Discussion to the size of the partition via a pragmatic mechanism, but the required mechanism is not obvious, and pursuing such a fix is outside the scope of this paper. On the other hand, the non-maximality account in Section 3 correctly predicts that exceptions are possibly irregular and dependent on the Question Under Discussion. Moreover, no special pragmatic mechanisms are required except those independently needed to account for definite plurals (Križ 2015).

4.3 Other related work

While Deo (2009) builds exception-tolerance into the theory of habituals by setting up a contextually-provided partition over times, and requiring that this partition match the times in the extension of the sentence radical, other approaches have attempted to weaken the truth-conditions of habituals by evaluating them with respect to primitive objects other than times and events.

Carlson (2008) analyzes both habitual and generic sentences using *patterns*. For Carlson, patterns are a primitive of the theory, and habituals and generics are true if and only if they are satisfied by a pattern. Patterns capture the non-accidental cooccurrence of events, and they naturally tolerate exceptions, unlike a restricted universal quantifier over times. Similarly, Bittner (2008) assumes the existence of *habits*, which are kinds at the event level. Habits, like patterns, are exception-tolerant by nature. These ideas are implemented very differently, and a detailed comparison would go beyond the scope of the present study. However, both approaches assume that there are some semantic primitives that are exception-tolerant by definition, and that these special objects serve as the truth-makers for habitual sentences, rather than more familiar objects such as times or events.

Though there may be independent reasons to include objects such as patterns or event-kinds in our models, neither account mentioned above is equipped to deal with the particular context-dependence of habitual sentences. As we have seen in Section 3, exceptions to habitual sentences are tolerated only if those exceptions are irrelevant to resolving the Question Under Discussion. This dimension of variation is unexpected on any analysis that attempts to weaken the truth conditions of habitual sentences by adding structured objects such as partitions, patterns, or habits.

Finally, a different approach, taken by Greenberg (2007), is to treat exception-tolerance in bare plural generics as a species of vagueness. The idea behind this approach is that generics are quantifiers, but their quantificational domain is vague. Thus, generics do not contain an exception-tolerant quantifier GEN, but instead contain a universal quantifier over a vague domain. Though Greenberg does not explicitly address habitual sentences like (42), one could imagine an extension of the vague quantifier domain theory to habituals.

In fact, Križ (2015: 40-42) notes that a unification of homogeneity and vagueness may be possible. However, there are two obstacles to such an approach. First, in borderline cases, vague predicates such as *tall* in (44) can be affirmed and denied of the same individual (Alxatib & Pelletier 2011, Ripley 2011). In contrast, homogeneous predicates cannot be both affirmed and denied of the same plurality, even in cases like (45) when the predicate is true of a sizable proper subpart of that plurality.

(44) Bill is both tall and not tall. Križ 2015: 41:(137a)

(45) *Context: Half the books are in Dutch.* Križ 2015: 41:(137b)
The books are both in Dutch and not in Dutch.

Analogous examples with habitual sentences such as (46) are infelicitous, and therefore pattern with plural definites, rather than vague predicates.

(46) *Context: Ben shaves once a year.*
  # Ben both shaves and doesn't shave.

Second, Križ (2015: 42) notes that homogeneous predicates do not reproduce the Sorites paradox, though I omit the relevant examples for space reasons.

Most importantly, the vagueness approach to exception-tolerance does not straightforwardly explain the sensitivity of exceptions to the Question Under Discussion. Despite these arguments, a closer comparison of homogeneity and vagueness might be illuminating, especially since the origins of homogeneity and non-maximality are still not well-understood. Ultimately, a reductionist theory of homogeneity effects may be possible, but I leave such attempts to future work.

5 Formal details

In this section I describe the ingredients for a formal, compositional theory that derives trivalent meanings for temporal adverbials.

5.1 Preliminaries

To derive the predicted meanings of English sentences, I translate English expressions into expressions of a typed λ-calculus with three types: $\texttt{t}$ for truth values, $\texttt{e}$ for entities, and $\texttt{i}$ for time intervals. The translation function $\langle\cdot\rangle$ maps object language expressions to λ-terms, and the interpretation function $[\![\cdot]\!]^w_g$ maps λ-terms to their denotations in the world w under the assignment function g. I omit the assignment function g where it is not relevant.

Terms of type $\texttt{i}$ are interpreted as time intervals, elements of $D_{\texttt{i}}$. I assume that the domain of time intervals $D_{\texttt{i}}$ is equipped with both a precedence ordering and a mereological structure, following Krifka (1989) and subsequent work. The precedence relation $\ll$ is a strict partial order, and the mereological parthood relation $\leq$ is a weak partial order. We say that two intervals **overlap** if they have a part in common. No two intervals in the precedence relation may overlap: $s \prec t \to \neg(s \circ t)$. Every predicate of time intervals $S_{\texttt{it}}$ has a unique sum, which I write as $\bigoplus S$. I write $*S$ for the algebraic closure of S. Individuals ($D_{\texttt{e}}$) and time intervals ($D_{\texttt{i}}$) both obey the axioms of Classical Extensional Mereology. A reference for these axioms can be found in (Champollion 2017: 13-17).

Terms of type $\texttt{t}$ are interpreted as truth values, of which there are three: $D_{\texttt{t}} = \{0, 1, \star\}$. These can be read as *false*, *true*, and *indeterminate* respectively. I define the positive and negative extensions of a formula $p_{\texttt{t}}$ as follows (assuming p is type $\texttt{t}$).

$$[\![p]\!]^+_g = \{w \mid [\![p]\!]^w_g = 1\} \qquad [\![p]\!]^-_g = \{w \mid [\![p]\!]^w_g = 0\}$$

Following von Stechow (2009), I treat tenses as presuppositional. I represent semantic presuppositions using the ∂ operator, which is interpreted as follows.

(47) Semantic presuppositions — Beaver (1993)

For any type-t term $p_{\mathtt{t}}$, we define ∂ as follows:

$$[\![\partial(p)]\!]^w_g = \begin{cases} 1 & [\![p]\!]^w_g = 1 \\ \text{undefined} & \text{otherwise} \end{cases}$$

For simplicity, I do not assign indeterminate truth values to sentences with a presupposition failure. Instead, I assume that the interpretation function is partial, as shown above.

5.2 Logical translations

In what follows, $T_{\mathtt{it}}$ and $S_{\mathtt{it}}$ are predicates of time intervals, $r_{\mathtt{i}}$ is a free variable representing the reference time, and $s_{\mathtt{i}}$ is the event time, which can be bound by frame-setting adverbials (von Stechow 1995). The utterance time $u_{\mathtt{i}}$ is also a free variable here.[9]

The past tense presupposes that the reference time strictly precedes the utterance time ($r \ll u$). The present tense, on the other hand, presupposes that the reference time is *part* of the utterance time ($r \leq u$). These are the presuppositions commonly associated with tense (von Stechow 2009).

Both tenses assert that T is true of the event time s, and presuppose that the reference time is part of the event time. (This extra presupposition is not standard, but I abstract away from the perfective/imperfective distinction here.)

(48) a. $\langle \text{PAST} \rangle = \lambda T_{\mathtt{it}} \lambda s_{\mathtt{i}}.T(s) \wedge \partial(r \leq s) \wedge \partial(r \ll u)$

b. $\langle \text{PRES} \rangle = \lambda T_{\mathtt{it}} \lambda s_{\mathtt{i}}.T(s) \wedge \partial(r \leq s) \wedge \partial(r \leq u)$

I will illustrate the analysis using two simple present tense sentences that contain definite pluralities of events,

(49) a. Albert yawns.

b. When he is sleepy, Albert yawns.

First, consider the sentence (49a) with no frame adverbial. (50) shows the meaning of the sentence radical, which lacks tense. (51) shows the meaning of the full tensed sentence.

9 I treat the utterance time as a variable rather than an index to simplify the interpretation function.

(50) $\langle \text{Albert yawn} \rangle = \lambda t_{\mathtt{i}}[*\textbf{yawn}(t)(\textbf{a})]$

(51) $\langle \text{Albert yawns} \rangle$
$= \langle \text{PRES} \rangle (\langle \text{Albert yawn} \rangle)(f)$
$= \partial(r \leq f) \wedge \partial(r \leq u) \wedge *\textbf{yawn}(f)(\textbf{a})$
(Defined iff the reference time $g(r)$ is part of the event time $g(f)$ and $g(r)$ is in the present. True iff Albert yawns at $g(f)$.)

Notice that the event time argument has been saturated with a free variable f. Aside from the fact that f must lie within the reference time (which is presupposed by PRES) we rely entirely on the assignment function to provide its value. Thus, bare habituals with no temporal adverbials involve plural predication of times by default, as required by the homogeneity analysis.

From here on I adopt the following abbreviations, since the presuppositions of tense morphemes are not central to the point. These abbreviations will reduce clutter in sentences with embedded tensed clauses.

(52) a. $\partial^{r,u}_{\text{PRES}}(s) := \partial(r \leq s) \wedge \partial(r \leq u)$
b. $\partial^{r,u}_{\text{PAST}}(s) := \partial(r \leq s) \wedge \partial(r \ll u)$

Moreover, I assume the following entry for *when*, which takes the sum of all times in the extension of a tensed clause and asserts that the sum is in the extension of the main clause. In Section 5.5, I revise this analysis to account for a broader set of facts, but the analysis of homogeneity effects will be unaffected.

(53) $\langle \text{when} \rangle = \lambda T_{\mathtt{it}} \lambda S_{\mathtt{it}}.S(\bigoplus(T))$ (to be revised in Sec. 5.5)

I assume that the reference time r and the utterance time u of the *when*-clause are the same as the reference time and utterance time of the main clause.

Now consider a bare (meaning unquantified) habitual with a frame adverbial. Here, the event time argument is saturated by the **supremum** of all the times at which Albert is sleepy.

(54) $\langle \text{When he is sleepy, Albert yawns.} \rangle$
$= \langle \text{when} \rangle [\langle \text{PRES} \rangle (\langle \text{Albert be sleepy} \rangle)][\langle \text{PRES} \rangle (\langle \text{Albert yawn} \rangle)]$

The clause *Albert is sleepy* is a full tensed clause, so we analyze it as such.

(55) $\langle$Albert is sleepy$\rangle$
$= \langle\text{PRES}\rangle(\langle\text{Albert be sleepy}\rangle)$
$= \lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge *\mathbf{sleepy}(s)(\mathbf{a})$

Plugging this in, we get the final meaning for (54).

(56) $\langle$When he is sleepy, Albert yawns.$\rangle$
$= \langle\text{when}\rangle(\langle\text{PRES}\rangle(\langle\text{Albert be sleepy}\rangle))(\langle\text{PRES}\rangle(\langle\text{Albert yawn}\rangle))$
$= [\lambda t_i.\partial^{r,u}_{\text{PRES}}(t) \wedge *\mathbf{yawn}(t)(\mathbf{a})](\bigoplus[\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge *\mathbf{sleepy}(s)(\mathbf{a})])$
$= \partial^{r,u}_{\text{PRES}}(\bigoplus[\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge *\mathbf{sleepy}(s)(\mathbf{a})]) \wedge *\mathbf{yawn}(\bigoplus[\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge *\mathbf{sleepy}(s)(\mathbf{a})])(\mathbf{a})]$
(The present plurality of times when Albert is sleepy is a present plurality of times at which Albert yawns.)

The account presented so far illustrates the core idea behind the analysis of sentences like (49). In Section 5.3, I provide a definition of temporal homogeneity that derives the facts in Section 2. In Section 5.5, I complete the analysis of temporal adverbials by adding matching functions (Rothstein 1995).

5.3 Temporal homogeneity

We are now in a position to model temporal homogeneity. Recall the informal statement of the homogeneity generalization.

(57) **Homogeneity Generalization** Križ (2015)
A homogeneous predicate that is not true of a plurality *a* is undefined [indeterminate] of *a* if it is true of some plurality *b* that overlaps (i.e., has parts in common) with *a*.

Since the domain of times is nonatomic, all temporal predication involves pluralities. Thus, the following is a corollary of the above.[10]

(58) **Temporal Homogeneity**
If $T_{\mathtt{it}}$ is a homogeneous predicate of times, and $t_{\mathtt{i}}$ is a time interval, then $T(t) = \star$ whenever (i) $T(t) \neq 1$ and (ii) there exists some s such that $s \circ t$ and $T(s) = 1$.

At this point, I will assume that all predicates of times are homogeneous, and that all logical connectives ($\neg, \wedge, \vee, \forall, \exists$) are the Strong Kleene versions of these

10 The fully general statement of homogeneity for individuals and times requires trivalent type theory. The necessary formal details are given in Appendices A-B, and the general homogneity constraint is stated in (83).

connectives, where the third truth value is $\star$ (indeterminate). (See Appendices A-C for the formal details behind trivalent type theory.) In particular, the following predicates are both homogeneous.

(59) a. $\langle \text{Albert yawn} \rangle^g = \lambda t_{\mathtt{i}}[*\mathbf{yawn}(t)(\mathbf{a})]$

b. $\langle \text{Albert not yawn} \rangle^g = \lambda t_{\mathtt{i}}[\neg * \mathbf{yawn}(t)(\mathbf{a})]$

It follows that the following sentence is only true if Albert *never* yawns when he is sleepy. If Albert only occasionally yawns when he is sleepy, then (60) predicts that the sentence (49b) will be indeterminate.

(60) $\langle$When he is sleepy, Albert doesn't yawn.$\rangle$
$= \langle \text{when} \rangle(\langle \text{Albert is sleepy} \rangle)(\langle \text{Albert yawns} \rangle)$
$= [\lambda t_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(t) \wedge \neg * \mathbf{yawn}(t)(\mathbf{a})](\bigoplus[\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge *\mathbf{sleepy}(s)(\mathbf{a})])$
(The present plurality of times when Albert is sleepy is a present plurality of times at which Albert does *not* yawn.)

(61) $[\![(60)]\!]^w_g = 1$ iff the plurality $[\![\bigoplus[\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge *\mathbf{sleepy}(s)(\mathbf{a})]]\!]^w_g$ is an element of the set $\{t \in D_i \mid [\![\partial^{r,u}_{\text{PRES}}(t) \wedge \neg * \mathbf{yawn}(t)(\mathbf{a})]\!] = 1\}$

5.4 Backward compatibility: Ferreira (2005) and Deo (2009)

The purpose of this section is to reassure the reader that the present analysis is not incompatible with covarying readings of singular indefinites under habituals. This section is largely orthogonal to the main point, and can be skipped if desired. First we consider the following set of contrasts. It is perfectly natural to say (62a), with a plural indefinite theme. But it is infelicitous to say (62b), with a singular indefinite, out of the blue. The intuitive source of the problem is that (62b) seems to convey that Albert smoked the *same* cigarette on separate occasions.

(62) Singular indefinites don't covary

a. Albert smokes cigarettes. — Ferreira 2005: 103:(23)

b. # Albert smokes a cigarette. — Ferreira 2005: 107:(36)

This is further evidence that the iterative reading does not involve a quantificational adverb scoping over the verb phrase. Unsurprisingly, the presence of a quantificational adverbial rescues the sentence.

(63) a. Every time Albert is angry, he smokes a cigarette.

b. Albert always smokes a cigarette.

But perhaps more surprisingly, given what we have said so far, bare habituals with a *when*-clause do not suffer from this problem. This issue can be solved without introducing a silent quantificational adverb if we assume that this is an instance of covert phrasal distributivity over times (Schwarzschild 1996, Deo 2009, Champollion 2017).

(64) When Albert is angry, he smokes a cigarette.

Covert distributivity can be introduced using the Part operator (Schwarzschild 1996), whose temporal version is defined in (65).

(65) $\text{Part}_C = \lambda T_{\texttt{it}} \lambda t_{\texttt{i}}.\forall s_{\texttt{i}}[(C(s) \wedge s \leq t) \rightarrow T(s)]$

Armed with the Part operator, we can now account for (64) while maintaining that the *when*-clause is a definite description of times.

(66) $\text{Part}_C(\langle\text{Albert smokes a cigarette}\rangle)$
$= \text{Part}_C(\lambda s_{\texttt{i}}.\exists x[\mathbf{cig}(x) \wedge {*}\mathbf{smoke}(s)(x)(\mathbf{a})])]$
$= \lambda t_{\texttt{i}}.\forall s_{\texttt{i}}[C(s) \wedge s \leq t \rightarrow \exists x[\mathbf{cig}(x) \wedge {*}\mathbf{smoke}(s)(x)(\mathbf{a})]]$
(True of a time t if its contextually segmented parts are times at which Albert smokes a cigarette.)

The major consequence of this approach, and what sets it apart from Ferreira (2005) in particular, is that the partition of the event time into a quantized set is not guaranteed by the logical or algebraic properties of predicates and their predicables, but rather by the extrasentential context. A natural worry is that this move deprives us of the tools that we use to account for sentences like (62b).

However, this dependence on the context is actually a welcome result, due to examples like those in (67). Iterative readings with singular indefinites are entirely natural whenever the context provides a natural antecedent for the reference time, along with a salient contextual cover. These kinds of examples involve cross-clausal temporal subordination (Roberts 2012).

(67) Temporal subordination

a. When Albert is sleepy, he has a method for staying awake. He drinks **a coffee**, stretches his legs, and washes his face.

b. What does the doctor do when she is bored? She goes for **a walk**, or she smokes **a cigarette**.

c. On Wednesdays, I take a long lunch break. I play **a game of tennis**, or listen to **an album**.

d. The patient took **one pill** for a month.

The basic methods here are not novel, but they are perfectly compatible with an analysis of both definite frame adverbials, and anaphora to discontinuous times, which are crucial ingredients of the homogeneity account.

5.5 Temporal adverbials more generally

So far, the formal analysis has only covered a few very simple bare habituals with *when*-clauses. In this section I show how the analysis extends to sentences with other kinds of temporal adverbials. Both quantificational and non-quantificational adverbials that participate in iterative readings have an interesting property first established by Rothstein (1995). They establish a one-to-one mapping from events described by the adverbial to events described by the main clause. For example, in (68) there is a mapping from events of paying a phone bill to events of losing the receipt, and the truth of the sentence depends on there being a different receipt for each phone bill.

(68) Every time I pay a phone bill, I end up losing the receipt. Rothstein 1995: 23:(70)

To account for this one-to-one correspondence, Rothstein introduces a **matching function** to the semantics of temporal adverbials. The matching function is an injective function from adverbial-events to main clause-events.

I assume that matching functions are present in all temporal adverbials, whether they are quantificational or not. This is because, in all the examples in (69), the event time is a proper part of the time denoted by the frame adverbial.

(69) a. Albert cooks Mapo Tofu every Tuesday.

b. Albert cooks Mapo Tofu on Tuesdays.

c. Albert cooks Mapo Tofu when it's Tuesday.

In fact, we can say something even stronger: for each connected component of the frame time, there is a distinct connected component of the event time. For each Tuesday, there is a cooking-Mapo-Tofu event. Thus, extending matching functions from Q-adverbs non-quantificational frame adverbs neatly accounts for the parallels.

The matching function may encode very little information other than the one-to-one relationship, as in (68), or it may encode a causal relationship as in (70), or mere temporal coincidence as in (71).

(70) Every time I see a horror movie, I have nightmares. Rothstein 1995: 14:(48)

(71) Every time Bill buys a donkey, John sells one. Rothstein 1995: 13:(45b)

For this reason, Rothstein assumes that the matching function is semantically present, but its precise meaning is resolved by considering the lexical and pragmatic context.

Since the context-dependent relation encoded by the matching function is not crucial for me, I will ignore it. I formalize matching functions using a higher-order predicate **match** of type $(\mathtt{ii})\mathtt{t}$. For a function symbol $M_{\mathtt{ii}}$ from time intervals to time intervals, we define the predicate **match** as follows.

(72) Definition of Matching Functions
$\mathbf{match}(M) := \forall s \forall t[M(s \oplus t) = M(s) \oplus M(t)] \wedge \forall s \forall t[M(s) = M(t) \rightarrow s = t]$
(A function M from times to times is a matching function if it is an injective sum homomorphism—i.e. if it preserves sums, and each distinct input is mapped to a distinct output.)

I follow Champollion (2017: 229) in requiring that matching functions be sum homomorphisms. Recall that when $S_{\mathtt{it}}$ is a predicate of times, $\bigoplus S$ is its (possibly discontinuous) sum. Definition (72) guarantees the identity in (73).

(73) Matching Identity
If $\mathbf{match}(M)$ is true and S is any predicate of times, then we have:
$M(\bigoplus S) = \bigoplus[\lambda t_{\mathtt{i}}.\exists s[S(s) \wedge M(s) = t]]$
(The image of the sum $\bigoplus S$ under M is equal to the sum of the image of S under M.)

The matching function M will be treated as a free variable throughout.

For quantificational adverbials, I follow Rothstein in assuming that they universally quantify over the domain of the matching function and existentially quantify over the range.

(74) $\langle$(on) every morning$\rangle = \lambda T_{\mathtt{it}}.\mathbf{match}(M) \wedge \forall s[\mathbf{morning}(s) \rightarrow T(M(s))]$
(A predicate of times $T_{\mathtt{it}}$ is *(on) every morning* if the matching function maps every morning-time to a T-time.)

For non-quantificational adverbials, I assume that the predicate of times given by the main clause applies to the sum of the range of M. Thus, non-quantificational adverbials involve plural predication, as required by the theory of temporal homogeneity established in the previous section.

(75) $\langle$when it's morning$\rangle = \lambda T_{\mathtt{it}}.\mathbf{match}(M) \wedge T(M[\bigoplus(\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge \mathbf{morning}(s))])$
(A predicate of times $T_{\mathtt{it}}$ is *when it's morning* if the matching function maps the sum of all present morning times in the present to a T-time.)

To see how this guarantees the intuitive mapping from morning-times to minimal S-times, let's look at an example.

(76) $\langle$When it's morning, Albert yawns$\rangle =$
$\langle$when it's morning$\rangle(\lambda t_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(t) \wedge *\mathbf{yawn}(t)(\mathbf{a})) =$
$[\lambda t_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(t) \wedge *\mathbf{yawn}(t)(\mathbf{a})](M[\bigoplus(\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge \mathbf{morning}(s))])$
(The sum of all present morning-times is matched to a plurality of times at which Albert yawns.)

Since the predicate $*$**yawn** is closed under sums, the image under M of the sum of present-morning-times must be a sum of minimal **yawn**-times. If we assume further that the minimal **yawn**-times are self-connected intervals, then the properties of the matching function guarantee that there will be at least one self-connected minimal $*$**yawn**-interval for each morning.

Put simply, each morning-time is mapped to a single instance of Albert yawning, as desired, and this is accomplished without assuming the existence of a universal quantifier over mornings. This is crucial, because treating *when*-clauses as quantificational adverbials would make it impossible to model the homogeneity and non-maximality of bare habituals with *when*-clauses.

For example, the negation of (76) has the expected reading, subject to homogeneity effects.

(77) $\langle$When it's morning, Albert doesn't yawn$\rangle =$
$\langle$when it's morning$\rangle(\lambda t_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(t) \wedge \neg * \mathbf{yawn}(t)(\mathbf{a})) =$
$(\lambda t_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(t) \wedge \neg * \mathbf{yawn}(t)(\mathbf{a}))[M[\bigoplus(\lambda s_{\mathtt{i}}.\partial^{r,u}_{\text{PRES}}(s) \wedge \mathbf{morning}(s))]]$
(The sum of all present morning-times is matched to a plurality of times at which Albert does *not* yawn.)

For more derivations of quantified and unquantified habituals with matching functions, see the fragment in Appendix C.

5.6 Interim conclusion

In this section, I have described a compositional semantics for quantified and bare habitual sentences that delivers the meanings required by their homogeneity effects (Section 2) and non-maximality (Section 3). The analysis combines existing tools from the literature in a new way, to derive a meaning for bare habituals according to which unquantified temporal adverbials are interpreted as definite pluralities of times. A bare habitual is true only if the sum denoted by the temporal adverbial is mapped homomorphically to a plurality of times at which the main clause predicate is true.

6 Conclusion

I have defended a view of habitual readings in English on which they are not produced by specialized aspectual operators, but instead arise naturally from independently motivated assumptions about plural predication. On this view, the exception-tolerance of habituals and the behavior of habituals under negation follow from the assumption that plural predication in general obeys homogeneity: the positive and negative extensions of temporal predicates must not overlap.

This theory has three advantages over existing alternatives, which I have outlined in Section 4. First, it is conceptually simple. It does not require expanding the ontology of natural language semantics beyond the standard assumptions of algebraic semantics (Krifka 1998). As a result, the theory is modular, and can easily be extended to be compatible with event semantics and modal analyses of the imperfective (e.g. Deo 2009). Second, it naturally accounts for the facts in Section 3, which show that the exception-tolerance of habituals depends on the partition provided by the QUD. No other existing account captures this dependence. Third, it provides a unified perspective on disparate phenomena. The data in Section 2 shows that habitual sentences resemble plural definites, and that this resemblance is confirmed by multiple diagnostics. This resemblance follows from a deep symmetry between the semantics of these expressions.

Appendix A: Trivalent Type Theory

In this section I provide the formal details of the trivalent type theory used by Križ (2015), which I adapt for this work. I will not repeat Križ's presentation here. Instead I will review the most important ideas, and direct the reader to Križ (2015: Chapter 2) and Lepage (1992) for further details. The key idea is that partial functions—functions that are indeterminate for some values—can be ordered according to their indeterminacy, and this ordering follows from an ordering on the domain of truth values $D_{\texttt{t}}$.

Let $D_{\texttt{t}} = \{0, 1, \star\}$ and let $\leq_{\texttt{t}}$ be a partial order on $D_{\texttt{t}}$. Intuitively, $x \leq_{\texttt{t}} y$ should be read as *x is at most as indeterminate as y*. The relation $\leq_{\texttt{t}}$ is given by (i) $x \leq_{\texttt{t}} x$ and (ii) $0, 1 \leq_{\texttt{t}} \star$. This gives a join semilattice in which (crucially) $\star$ overlaps with both 0 and 1, but 0 and 1 do not overlap. We will now extend this ordering to all functions.

The set of **types** $\mathscr{T}$ is the smallest set $\mathscr{T}$ such that $\mathtt{e}, \mathtt{i}, \mathtt{t} \in \mathscr{T}$, and if $\sigma, \tau \in \mathscr{T}$, then $\langle \sigma\tau \rangle \in \mathscr{T}$. I abbreviate types right-associatively, so that $\langle \sigma\tau \rangle \equiv \sigma\tau$, $\langle \rho \langle \sigma\tau \rangle \rangle \equiv \rho\sigma\tau$, and $\langle \langle \rho\sigma \rangle \tau \rangle \equiv (\rho\sigma)\tau$. Let the ordering $\leq_{\mathtt{t}}$ be as before, and let $\leq_{\mathtt{e}}$ and $\leq_{\mathtt{i}}$ stand for the usual mereological parthood relation on individuals $D_{\mathtt{e}}$ and time intervals $D_{\mathtt{i}}$ respectively.

By induction on types $\tau \in \mathscr{T}$, we can recursively extend the orderings on these basic domains to an ordering on an arbitrary domain D_τ in the following way. Let ρ be any basic type, i.e. $\rho \in \{\mathtt{e}, \mathtt{i}, \mathtt{t}\}$, so that $\leq_\rho$ is already defined. Thus, in the base case, where $\tau = \rho$, we have already defined the relation $\leq_\rho$. Now, suppose $\tau = \sigma\rho$, where $\sigma \in \mathscr{T}$ is an arbitrary type. In this case, for functions $f, g \in D_{\sigma\rho}$, we say that $f \leq_{\sigma\rho} g$ if and only if $f(x) \leq_\rho g(x)$ for all $x \in D_\sigma$. For the most general case, suppose $\sigma_0, \sigma_1, ..., \sigma_n \in \mathscr{T}$ are arbitrary types, and $\tau = \sigma_0\sigma_1...\sigma_n\rho$, where $\rho \in \{\mathtt{e}, \mathtt{i}, \mathtt{t}\}$ as before. For functions $f, g \in D_{\sigma_0\sigma_1...\sigma_n\rho}$, we say that $f \leq_{\sigma_0\sigma_1...\sigma_n\rho} g$ if and only if $f(x) \leq_{\sigma_1...\sigma_n\rho} g(x)$ for all $x \in D_{\sigma_0}$.

The implementation is complex, but the idea is simple. For example, consider two functions $f, g \in D_{\mathtt{et}}$ (imagine that f and g are the denotations of two intransitive verbs). Suppose $f(x)$ is determinate (1 or 0) on all individuals $x \in D_{\mathtt{e}}$, but $g(a) = \star$ for some particular individual $a \in D_{\mathtt{e}}$, and suppose further that $g(x) = f(x)$ for all $x \neq a$. In this case, $f \leq_{\mathtt{et}} g$, because $f(x) \leq_{\mathtt{t}} g(x)$ for all $x \in D_{\mathtt{e}}$. However, for example, (i) if f and g are indeterminate for *distinct* inputs, or (ii) if they assign 0 and 1 respectively to the same individual, then they will not be ordered by $\leq_{\mathtt{et}}$.

Given orderings $\leq_\tau$ for each type τ, we can also define a general notion of overlap. This notion of overlap is the key ingredient in Križ's formalization of homogeneity, given below in (78).

(78) Definition of Homogeneity — Križ 2015: 53:Def. 2.9

For any type $\sigma \in \mathscr{T}$, let $\circ_\sigma$ denote **overlap** with respect to the ordering $\leq_\sigma$ on the domain D_σ; that is to say, $x \circ_\sigma y$ if and only if there is a $z \in D_\sigma$ such that $z \leq_\sigma x$ and $z \leq_\sigma y$.

A function $f : D_\sigma \to D_\tau$ is **homogeneous** iff for all $x, y \in D_\sigma$, $(x \circ_\sigma y) \to f(x) \circ_\tau f(y)$.

For a simple example, suppose $f \in D_{\mathtt{et}}$ is a *homogeneous* function, and $a, b, c \in D_{\mathtt{e}}$ are individuals. Recall that $0 \circ_{\mathtt{t}} \star$ and $1 \circ_{\mathtt{t}} \star$, but $\neg(0 \circ_{\mathtt{t}} 1)$. According to the homogeneity generalization, if $f(a \oplus b) = 1$, then any $x \in D_{\mathtt{e}}$ that overlaps with $a \oplus b$ will be mapped to either 1 or $\star$ by f. Formally, if $x \circ_{\mathtt{e}} (a \oplus b)$, then homogeneity forces either $f(x) = 1$ or $f(x) = \star$; $f(x)$ may not be 0. In particular, $f(a)$ must be 1 or $\star$ and $f(a \oplus b \oplus c)$ must be 1 or $\star$. But, since c does not overlap with $a \oplus b$, $f(c) = 0$ is possible (as long as $f(a \oplus b \oplus c) \neq 1$).

Before moving on, let me comment on some differences between the presentation here and the presentation in Križ (2015: Ch. 2). First, Križ only uses types $\mathtt{e}$ and

$\mathtt{t}$, and he only defines the ordering $\leq_\tau$ for types ending in $\mathtt{t}$. I instead extend $\leq_\tau$ to the whole type hierarchy, treating the mereological parthood relations $\leq_\mathtt{e}$ and $\leq_\mathtt{i}$ on a par with the indeterminacy ordering $\leq_\mathtt{t}$.[11] More importantly, Križ discusses extensions of the trivalent type theory to cover collective predicates, non-homogeneous predicates, and non-monotonic quantifiers. I do not adopt these extensions here, so as not to obscure my key points, but it would certainly be possible to implement them.

Appendix B: The Language $\mathscr{L}$

I use a typed λ-calculus $\mathscr{L}$ with three types, truth values, entities, and times. The **syntax** of the λ-language $\mathscr{L}$ is entirely standard, so I will review it only briefly. In what follows, ρ, σ, τ are metavariables over types, and $\alpha, \beta, \mathbf{a}, \mathbf{b}, p, q, s, t, x, y$ are all metavariables over terms. For each type $\tau \in \mathscr{T}$, let $\mathscr{L}_\tau$ stand for the set of terms of type τ in $\mathscr{L}$. Let Var_τ stand for the set of variables of type τ, and let Con_τ stand for the set of constants of type τ. Then, $\mathscr{L}$ is the smallest set satisfying rules (i-x): (i) [Variables and Constants] $Var_\tau \cup Con_\tau \subseteq \mathscr{L}_\tau$, (ii) [Application] If $\alpha \in \mathscr{L}_{\sigma\tau}$ and $\beta \in \mathscr{L}_\sigma$, then $\alpha(\beta) \in \mathscr{L}_\tau$, (iii) [Abstraction] if $x \in Var_\sigma$ and $\alpha \in \mathscr{L}_\tau$, then $(\lambda x.\alpha) \in \mathscr{L}_{\sigma\tau}$.

We have the usual **logical symbols**: (iv) [Negation] If $p \in \mathscr{L}_\mathtt{t}$, then $(\neg p) \in \mathscr{L}_\mathtt{t}$, (v) [Disjunction, Conjunction, Implication] If $p, q \in \mathscr{L}_\mathtt{t}$, then $(p \wedge q), (p \vee q), (p \rightarrow q) \in \mathscr{L}_\mathtt{t}$, (vi) [Quantifiers] If $x \in Var_\tau$ and $p \in \mathscr{L}_\mathtt{t}$, then $(\forall x[p]), (\exists x[p]) \in \mathscr{L}_\mathtt{t}$.

We also have the following **non-logical symbols**: (vii) [Equality] if $\alpha, \beta \in \mathscr{L}_\tau$, then $(\alpha = \beta) \in \mathscr{L}_\mathtt{t}$, (viii) [Parthood, Overlap] if $\sigma \in \{\mathtt{e}, \mathtt{i}\}$ and $\alpha, \beta \in \mathscr{L}_\sigma$, then $(\alpha \preceq \beta), (\alpha \circ \beta) \in \mathscr{L}_\mathtt{t}$, (ix) [Sum] if $\sigma \in \{\mathtt{e}, \mathtt{i}\}$ and $\alpha \in \mathscr{L}_{\sigma\mathtt{t}}$, then $\bigoplus \alpha \in \mathscr{L}_\sigma$, and (x) [Precedence] if $s, t \in \mathscr{L}_\mathtt{i}$, then $(s \ll t) \in \mathscr{L}_\mathtt{t}$.

Now we define the **semantics** of $\mathscr{L}$. Let $\mathscr{M}$ be the set of all models. M is a **model** if $M = \langle \mathscr{I}_M, D_\mathtt{e}, \leq_\mathtt{e}, D_\mathtt{i}, \leq_\mathtt{i}, \ll_\mathtt{i}, W \rangle$, where (i) $\mathscr{I}_M$ is an interpretation function, (ii) $\langle D_\mathtt{e}, \leq_\mathtt{e} \rangle$, is an atomic join semilattice of individuals, (iii) $\langle D_\mathtt{i}, \leq_\mathtt{i} \rangle$ is a non-atomic join semilattice of times, (iv) $\langle D_\mathtt{i}, \ll_\mathtt{i} \rangle$ is a partially-ordered set of times (where $\ll_\mathtt{i}$ is the precedence ordering), and (v) W is a set of possible worlds. Independently of the choice of model M, the domain of **truth values** is always defined as $D_\mathtt{t} = \{0, 1, \star\}$, and is always ordered by $\leq_\mathtt{t}$ (defined in Appendix A). For any types $\sigma, \tau \in \mathscr{T}$, the functional domain $D_{\sigma\tau}$ is a set of functions from D_σ to D_τ.

The **denotation** function $[\![\cdot]\!]^w_{M,g}$ maps terms in $\mathscr{L}_\tau$ to model-theoretic objects (functions) in D_τ, for any type $\tau \in \mathscr{T}$, according to the rules in (79,80,81).

11 One could, using the definitions in this Appendix, define homogeneous functions to individuals or times, but the applications are not clear. This is just a convenience for me, since both Križ and I only force homogeneity for types ending in $\mathtt{t}$ anyway (see (83) in Appendix B).

(79) Basic Semantic Rules

a. (Variables) If $x \in Var$, then $[\![x]\!]^w_{M,g} = g(x)$.

b. (Constants) If $\mathbf{a} \in Con$, $[\![x]\!]^w_{M,g} = \mathscr{I}_M(\mathbf{a})$.

c. (Application) If $\alpha \in \mathscr{L}_{\sigma\tau}$ and $\beta \in \mathscr{L}_{\sigma}$, then $[\![\alpha(\beta)]\!]^w_{M,g} = [\![\alpha]\!]^w_{M,g}([\![\beta]\!]^w_{M,g})$.

d. (Abstraction) If $\lambda x.\alpha \in \mathscr{L}_{\sigma\tau}$, then $[\![\lambda x.\alpha]\!]^w_{M,g}$ is a function from $D_\sigma \to D_\tau$, given by $u \mapsto [\![\alpha]\!]^w_{M,g[x/u]}$.

(80) Rules for Logical Symbols

a. (Negation) If $p \in \mathscr{L}_{\mathtt{t}}$, then $[\![\neg p]\!]^w_{M,g} = \begin{cases} 1 & [\![p]\!]^w_{M,g} = 0 \\ 0 & [\![p]\!]^w_{M,g} = 1 \\ \star & \text{otherwise} \end{cases}$

b. (Conjunction) If $p, q \in \mathscr{L}_{\mathtt{t}}$, then $[\![p \wedge q]\!]^w_{M,g} = \begin{cases} 1 & [\![p]\!]^w_{M,g} = [\![q]\!]_{M,g} = 1 \\ 0 & [\![p]\!]^w_{M,g} = 0 \text{ or } [\![q]\!]^w_{M,g} = 0 \\ \star & \text{otherwise} \end{cases}$

c. (Disjunction) If $p, q \in \mathscr{L}_{\mathtt{t}}$, then $[\![p \vee q]\!]^w_{M,g} = \begin{cases} 1 & [\![p]\!]^w_{M,g} = 1 \text{ or } [\![q]\!]^w_{M,g} = 1 \\ 0 & [\![p]\!]^w_{M,g} = [\![q]\!]_{M,g} = 0 \\ \star & \text{otherwise} \end{cases}$

d. (Implication) If $p, q \in \mathscr{L}_{\mathtt{t}}$, then $[\![p \to q]\!]^w_{M,g} = [\![(\neg p) \vee q]\!]^w_{M,g}$

(81) Rules for Non-Logical Symbols

a. (Equality) $[\![\alpha = \beta]\!]^w_{M,g} = 1$ iff $[\![\alpha]\!]^w_{M,g} = [\![\beta]\!]^w_{M,g}$, and 0 otherwise.

b. (Precedence) For $s, t \in \mathscr{L}_{\mathtt{i}}$, $[\![\alpha \ll \beta]\!]^w_{M,g} = 1$ iff $[\![s]\!]^w_{M,g} \ll_{\mathtt{i}} [\![t]\!]^w_{M,g}$, and is 0 otherwise.

c. (Parthood) For $\sigma \in \{\mathtt{e}, \mathtt{i}\}$, and $\alpha, \beta \in L_\sigma$, $[\![\alpha \leq \beta]\!]^w_{M,g} = 1$ iff $[\![\alpha]\!]^w_{M,g} \leq_\sigma [\![\beta]\!]^w_{M,g}$, and equals 0 otherwise.[12]

d. (Overlap) For $\sigma \in \{\mathtt{e}, \mathtt{i}\}$, and $\alpha, \beta \in L_\sigma$, $[\![\alpha \circ \beta]\!]^w_{M,g} = 1$ iff $[\![\alpha]\!]^w_{M,g} \circ_\sigma [\![\beta]\!]^w_{M,g}$, i.e. there exists some $z \in D_\sigma$ such that $z \leq_\sigma [\![\alpha]\!]^w_{M,g}$ and $z \leq_\sigma [\![\beta]\!]^w_{M,g}$, and equals 0 otherwise.

e. (Sum) For $\sigma \in \{\mathtt{e}, \mathtt{i}\}$, and $\alpha \in L_{\sigma\mathtt{t}}$, $[\![\bigoplus \alpha]\!]^w_{M,g}$ is the unique sum of the set $\{x \in D_\sigma \mid [\![\alpha]\!]^w_{M,g}(x) = 1\}$.

12 Though I define $\leq_\tau$ for all types τ in Appendix A, I assume that the symbol $\leq$ in $\mathscr{L}$ only denotes mereological parthood.

We impose the following constraints on admissible models:

(82) $M = \langle \mathscr{I}_M, D_{\mathtt{e}}, \leq_{\mathtt{e}}, D_{\mathtt{i}}, \leq_{\mathtt{i}}, \ll_{\mathtt{i}}, W \rangle$ is an admissible model iff:

a. (CEM) Both individuals $\langle D_{\mathtt{e}}, \leq_{\mathtt{e}} \rangle$ and times $\langle D_{\mathtt{i}}, \leq_{\mathtt{i}} \rangle$ satisfy all the axioms of Classical Extensional Mereology (Champollion 2017: 13-17).

b. (Precedence and Overlap) All and only non-overlapping pairs of time intervals are in the precedence relation, i.e. $\forall x, y \in D_{\mathtt{i}}[(x \ll_{\mathtt{i}} y) \vee (y \ll_{\mathtt{i}} x) \leftrightarrow \neg(x \circ y)]$.

With all this in place, we can formally state the homogeneity constraint, where *homogeneous* is defined in (78) in Appendix A. This constraint requires that functions of all types ending in $\mathtt{t}$ are homogeneous.[13]

(83) Homogeneity Constraint
For all $\sigma_1, .., \sigma_n \in \mathscr{T}$, the domain $D_{\sigma_1 \ldots \sigma_n \mathtt{t}}$ must be a set of homogeneous functions.

Appendix C: A Formal Fragment

This appendix contains an explicit fragment with derivations for a few interesting sentences. $\langle \cdot \rangle$ is a function from object language expressions (parsed English phrases) to terms in $\mathscr{L}$. The compositional order is given by the syntactic parse in the following way: If ε and δ are object-language expressions, then $\langle\ [\ \varepsilon\ [\ \delta\ ]\ ]\ \rangle = \langle\ [\ [\ \delta\ ]\ \varepsilon\ ]\ \rangle = \langle \varepsilon \rangle(\langle \delta \rangle)$.

(84) a. $\langle \text{PAST} \rangle = \lambda T_{\mathtt{it}} \lambda s_{\mathtt{i}}.T(s) \wedge \partial(r \leq s) \wedge \partial(r \ll u)$

b. $\langle \text{PRES} \rangle = \lambda T_{\mathtt{it}} \lambda s_{\mathtt{i}}.T(s) \wedge \partial(r \leq s) \wedge \partial(r \leq u)$

(85) $\langle$Annie runs$\rangle$ = $\langle$[[[Annie] run] -s]$\rangle$ = $\langle \text{PRES} \rangle(\langle \text{run} \rangle(\langle \text{Annie} \rangle)) = \lambda t_{\mathtt{it}}.\partial^{g,r}_{\text{PRES}}(t) \wedge \mathbf{run}(\mathbf{a})(t)$

(86) $\langle \text{on} \rangle = \lambda A_{(\mathtt{it})\mathtt{t}} \lambda T_{\mathtt{it}}.\mathbf{match}(M) \wedge A(\lambda u_{\mathtt{i}}.T(M(u)))$

13 Križ (2015) discusses how to account for non-homogeneous functions as well, but introducing them further complicates the logic, so I set them aside.

(87) $\langle$every Saturday$\rangle = \lambda R_{\texttt{it}}.\forall s_{\texttt{i}}[\textbf{saturday}(s) \rightarrow R(s)]$

(88) $\langle$[on [every Saturday]]$\rangle = \langle$on$\rangle(\langle$every Saturday$\rangle) = \lambda T_{\texttt{it}}.\textbf{match}(M) \wedge \forall s_{\texttt{i}}[\textbf{saturday}(s) \rightarrow T(M(s))]$

(89) $\langle$[[Annie runs] [on [every Saturday]]]$\rangle = \textbf{match}(M) \wedge \forall s_{\texttt{i}}[\textbf{saturday}(s) \rightarrow \partial^{g,r}_{\text{PRES}}(M(s)) \wedge \textbf{run}(\textbf{a})(M(s))]$

(90) $\langle$Saturdays$\rangle = \lambda R_{\texttt{it}}.R[\bigoplus(\textbf{saturday})]$

(91) $\langle$[on [Saturdays]]$\rangle = \lambda T_{\texttt{it}}.\textbf{match}(M) \wedge T(M[\bigoplus(\textbf{saturday})])$

(92) $\langle$[[Annie runs] [on [Saturdays]]]$\rangle = \textbf{match}(M) \wedge \partial^{g,r}_{\text{PRES}}[M(\bigoplus(\textbf{saturday}))] \wedge \textbf{run}(\textbf{a})[M(\bigoplus(\textbf{saturday}))]$

References

Alxatib, Sam & Francis Jeffry Pelletier. 2011. The Psychology of Vagueness: Borderline Cases and Contradictions. *Mind and Language* 26(3). 287–326. https://doi.org/10.1111/j.1468-0017.2011.01419.x.

Beaver, David I. 1993. *The Kinematics of Presupposition*.

Bittner, M. 2008. Aspectual universals of temporal anaphora.

Carlson, Greg. 2008. Patterns in the Semantics of Generic Sentences. In Jacqueline Guéron & Jacqueline Lecarme (eds.), *Time and Modality* Studies in Natural Language and Linguistic Theory, 17–38. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-1-4020-8354-9_2.

Carlson, Greg. 2012. *Habitual and Generic Aspect*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195381979.013.0029.

Champollion, Lucas. 2017. *Parts of a Whole: Distributivity as a Bridge between Aspect and Measurement* Oxford Studies in Theoretical Linguistics. Oxford, New York: Oxford University Press.

Deo, Ashwini. 2009. Unifying the imperfective and the progressive: Partitions as quantificational domains. *Linguistics and Philosophy* 32(5). 475–521. https://doi.org/10.1007/s10988-010-9068-z.

Dowty, David R. 1979. Interval Semantics and the Progressive Tense. In David R. Dowty (ed.), *Word Meaning and Montague Grammar: The Semantics of Verbs and Times in Generative Semantics and in Montague's PTQ* Studies in Linguistics and Philosophy, 133–192. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-009-9473-7_3.

Ferreira, Marcelo. 2005. *Event quantification and plurality*: Massachusetts Institute of Technology dissertation.

Fodor, Janet Dean. 1970. *The linguistic description of opaque contents.*: Massachusetts Institute of Technology Thesis.

Gajewski, Jon Robert. 2005. *Neg-raising: Polarity and presupposition*: Massachusetts Institute of Technology Thesis.

Greenberg, Yael. 2007. Exceptions to Generics: Where Vagueness, Context Dependence and Modality Interact. *Journal of Semantics* 24(2). 131–167. https://doi.org/10.1093/jos/ffm002.

Grice, H. P. 1975. Logic and Conversation. *Speech Acts* 41–58. https://doi.org/10.1163/9789004368811_003.

Krifka, Manfred. 1989. Nominal Reference, Temporal Constitution and Quantification in Event Semantics 21.

Krifka, Manfred. 1998. The Origins of Telicity. In Susan Rothstein (ed.), *Events and Grammar* Studies in Linguistics and Philosophy, 197–235. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-011-3969-4_9.

Križ, Manuel. 2015. *Aspects of Homogeneity in the Semantics of Natural Language*: University of Vienna dissertation.

Križ, Manuel. 2016. Homogeneity, Non-Maximality, and all. *Journal of Semantics* 33(3). 493–539. https://doi.org/10.1093/jos/ffv006.

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

Landman, Fred. 1992. The progressive. *Natural Language Semantics* 1(1). 1–32. https://doi.org/10.1007/BF02342615.

Lasersohn, Peter. 1999. Pragmatic Halos. *Language* 75(3). 522–551. https://doi.org/10.2307/417059.

Lepage, François. 1992. Partial functions in type theory. *Notre Dame Journal of Formal Logic* 33(4). 493–516. https://doi.org/10.1305/ndjfl/1093634483.

Löbner, Sebastian. 1985. Definites. *Journal of Semantics* 4(4). 279–326. https://doi.org/10.1093/jos/4.4.279.

Magri, Giorgio. 2014. An Account for the Homogeneity Effect Triggered by Plural Definites and Conjunction Based on Double Strengthening. In Salvatore Pistoia Reda (ed.), *Pragmatics, Semantics and the Case of Scalar Implicatures* Palgrave Studies in Pragmatics, Language and Cognition, 99–145. London: Palgrave Macmillan UK. https://doi.org/10.1057/9781137333285_5.

Malamud, Sophia A. 2012. The meaning of plural definites: A decision-theoretic approach. *Semantics and Pragmatics* 5(0). 3–1–58. https://doi.org/10.3765/sp.5.3.

Portner, Paul. 1998. The Progressive in Modal Semantics. *Language* 74(4). 760–87.

Ripley, David. 2011. Contradictions at the Borders. In Rick Nouwen, Robert van Rooij, Uli Sauerland & Hans-Christian Schmitz (eds.), *Vagueness in Communication*, 169–188. Springer.

Roberts, Craige. 2012. Information Structure: Towards an integrated formal theory of pragmatics. *Semantics and Pragmatics* 5(0). 6–1–69. https://doi.org/10.3765/sp.5.6.

Rothstein, Susan. 1995. Adverbial quantification over events. *Natural Language Semantics* 3(1). 1–31. https://doi.org/10.1007/BF01252883.

Schwarzschild, Roger. 1996. *Pluralities* Studies in Linguistics and Philosophy. Springer Netherlands. https://doi.org/10.1007/978-94-017-2704-4.

von Fintel, Kai. 1997. Bare Plurals, Bare Conditionals, and Only. *Journal of Semantics* 14(1). 1–56. https://doi.org/10.1093/jos/14.1.1.

von Stechow, Arnim. 1995. Tense in Intensional Contexts: Two Semantic Accounts of Abusch's Theory of Tense. http://www.sfs.uni-tuebingen.de/~astechow/Aufsaetze/TenseAbusch.pdf.

von Stechow, Arnim. 2009. Tenses in Compositional Semantics. In Wolfgang Klein & Ping Li (eds.), *The Expression of Time*, Berlin, Boston: De Gruyter Mouton.