



Zsófia Gyarmathy and Daniel Altshuler*

(Non)culmination by abduction

Abstract: Recent literature has aimed to explain (non-)culminating accomplishment inferences, which often involve the perfective aspect, but can also involve the imperfective. The goal of our paper is to explore how these inferences come about with the Hindi perfective and the Russian imperfective. We propose that *abduction*, that is, inference to the best explanation, is ideally suited for this task. We show how the occurrence of a (non-)culminated event is abduced in the relevant cases based on a semantic analysis which adopts the distinction between *culminated* and *maximal* events, as well as a set of non-defeasible rules encoding general mereological principles. We also show how our abductive framework can take into account facts about the conversation. This, among other things, allows us to make more nuanced predictions about what speakers will infer and when, thereby addressing possible worries of overgeneralization that an abductive framework inevitably faces. We end the paper with two outstanding issues warranting further research. First, we raise questions about the nature of (non-)culminating accomplishment inferences, which have previously been taken to be conversational implicatures. Second, we take some preliminary steps towards extending our analysis to defeasible causatives in Germanic and Romance languages.

Keywords: perfective aspect, imperfective aspect, culmination, maximal events, defeasible inferences, abduction

1 The explanandum: culmination implicature

The past three decades have seen an increasing amount of research into sentences that fail to entail an expected culmination (see Demirdache and Martin 2015 for an overview). For example, non-culminating construals of accomplishments in the perfective aspect have been reported in languages such as Mandarin Chinese (Smith 1991), Hindi (Singh 1991; 1998), Thai (Koenig and Muansuwan 2000), Salish languages (Bar-El et al. 2005), Tamil (Pederson 2008) and Karachay-Balkar (Tatevosov 2008). The Hindi example in (1) from Singh (1991) illustrates this phenomenon: the perfective *khaayaa* ('eat') is used to describe an eating event that culminated. However, the perfective description is compatible with the eating event not having culminated, as the follow-up in parenthesis shows.¹

- (1) *maĩne aaj apnaa kek khaayaa (aur baakii kal khaũũgaa)*
I.ERG today mine cake eat.PFV and remaining tomorrow eat.FUT
'I ate my cake today (and I will eat the remaining part tomorrow).'

In addition, extensive arguments have been put forth that some languages, like Russian, have what Smith (1991) called a *neutral viewpoint* aspect, which is unlike the perfective or the imperfective in allowing for both of what she called "closed"/"open" readings (i.e., a described event has/has not culminated). In this paper, we will consider the imperfective in Russian, which we argue carries a defeasible inference of completion, or culmination, in minimal contexts (which we will specify more closely). As an example, consider (2), which in out-of-the-blue contexts tends to be interpreted as asking about a culminated reading event. However, (2) is also compatible with a non-culminated event reading (i.e. 'Who was engaged in reading "War and Peace"?'):²

¹ The following abbreviations are used in the glosses in the paper: DET = determiner, ERG = ergative, FUT = future, IPF = imperfective, NOM = nominative, PFV = perfective, PST = past, SG = singular, SU = subject, TR = transitive.

² In what follows, we focus on these two interpretations of the Russian imperfective. Note, however, that this aspect has other interpretations as well; see, e.g., Forsyth (1970), Glovinskaja (1982; 1989), Paducheva (1995) and Grønn (2003) for more discussion.

- (2) *Kto čital “Vojnu i Mir”?*
 who read.PST.IPF “War and Peace”
 ‘Who has read “War and Peace”?’ (Grønn 2008)

In this paper, we will focus on the Hindi perfective³ in (1) (henceforth PFV_H) and the Russian imperfective (henceforth IPF_R). Following Smith (1991), Bohnemeyer and Swift (2004), Dahl (2010) and others, we assume that the phenomena exhibited by these aspects have a common explanation. However, unlike the just mentioned authors, we follow Altshuler (2013; 2014) in rejecting an explanation in terms of neutral aspect. Instead, building on the analyses of Koenig and Muansuwan (2000) and Filip (1999; 2000), we assume that: (i) a perfective, but not an imperfective operator requires reference to *maximal* parts, and (ii) both PFV_H and IPF_R denote partitive operators that allow, but do not require, reference to *proper* parts of an event of the relevant kind. This semantic analysis can explain the lack of a culmination entailment in the relevant forms, but this only constitutes the first building block for our purposes: our focus lies not in explaining the possibility of a non-culminating construal, but in explaining why a culminating construal of PFV_H and IPF_R is prominent. We are interested in why it is that – without further context (e.g. elaborations concerning an event’s culmination) – PFV_H and IPF_R lead to a *culmination implicature*, as the data in (1) and (2) suggest.⁴ Our goal will be to account for how this culmination implicature arises, something that is missing in much of the research on non-culminated accomplishments and neutral aspect (e.g., Singh 1998; Koenig and Muansuwan 2000; Tatevosov 2008), where the goal is to explain the lack of a culmination entailment.

When the culmination implicature is addressed in the literature,⁵ an appeal is typically made to (Neo-)Gricean pragmatics and/or competition between different linguistic forms. While we agree that an essentially pragmatic account is necessary to explain the culmination implicature, we will argue for the benefits of using an alternative pragmatic account, namely, one exploiting *abductive reasoning*, that is, inference to the best explanation. This approach couches the defeasible culmination inference within a broader theory of human reasoning. Indeed, the abductive approach is compatible with (Neo-)Gricean pragmatics. While Levinson (2000: 61) maintained that there is “little hope of reducing [generalized conversational implicatures]” to accommodation and abductive reasoning (he himself regarded pragmatic principles as *constraining* the inference process), Gricean and Neo-Gricean pragmatics have been argued to involve abductive reasoning (Dascal 1977; Hobbs et al. 1993; Hobbs 2004).⁶ As Hobbs (2004: 730) put it, “an implicature can be viewed as an abductive move for the sake of achieving the best interpretation”. We would like to contribute to this discussion and show some benefits of approaching pragmatic reasoning (whether or not it involves conversational implicatures) as abduction. To that end, we offer an abduction-based account of defeasible culmination inferences in Hindi and Russian.

Moreover, we take some preliminary steps towards extending our account to verbal predicates that Martin and Schäfer (2012) call *defeasible causatives*:

- (3) a. Ivan taught me Russian, but I did not learn anything.
 b. Lipson’s textbook taught me Russian, #but I did not learn anything. (Martin and Schäfer 2017)

According to Martin and Schäfer (2012), Demirdache and Martin (2015), Martin (2015) and Martin and Schäfer (2017), defeasible behaviour is restricted in these verbs to cases where an agent has control over the event, cf. the contrast in (3). We take preliminary steps in showing how our abduction analysis can incorporate

³ We will mostly discuss the simple verb perfective (*SV-perfective*) and will not be concerned with the complex verb perfective (*CV-perfective*), which does not allow for non-culminating construals (cf. Singh 1991; 1998 – though see Arunachalam and Kothari 2010 for experimental evidence suggesting that it does to a limited extent).

⁴ Cf. Pancheva’s (2003) claim that the use of neutral aspect never leads to an entailment that the described event has culminated; this inference constitutes an implicature (cf. Smith 1991). However, as is known and will be discussed below, achievements are crucially different from accomplishments in this respect. Similar observations have been made for other non-culminating forms, cf. references in fn. 5, though the specifics differ by language and construction.

⁵ See Smith (1991); Grønn (2003; 2007); Bohnemeyer and Swift (2004); Bar-El et al. (2005); Arunachalam and Kothari (2010; 2011); Altshuler (2014).

⁶ A third possible take on the connection between abduction and pragmatic reasoning has been suggested by Károlyi Varasdi (p.c.), who proposed that (Neo-)Gricean cooperativity principles can be used as criteria in determining what counts as a *better* explanation and so influence the abduced inferences in that way.

this insight in a natural way by building on Martin’s (2015) semantic analysis.

The structure of the paper is as follows. In the next section, we provide an overview of previous attempts to explain the culmination implicature. Subsequently, in Section 3, we introduce the abduction framework that we extend to the Hindi and Russian data in Section 4. In Section 5, we reassess the status of the defeasible culmination inference as being an implicature. Finally, in Section 6, we discuss how our analysis could be extended to account for data such as (3) and conclude this paper in Section 7.

2 Former accounts of the culmination implicature

There are several analyses of non-culminating accomplishments that attempt to address why culmination is implicated in forms allowing for both culminating and non-culminating construals. To the best of our knowledge, all these analyses rely on (Neo-)Gricean pragmatic reasoning and/or a competition between different linguistic forms available in a language. In what follows, we briefly outline some of these analyses and assess whether they could be extended to explain the aforementioned data involving PFV_H and IPF_R.

In discussing non-culminating simple forms in Tamil, Pederson (2008: 347) proposes that “the regular association of the verb with a construction that entails realization may *reduce the need to interpret the verb as also having the same entailment of realization* when it occurs alone” (our emphasis), so a non-culminating interpretation is the result of a “metonymic process whereby a verb is used to refer to only a subpart of the verb’s complete semantic representation” (349). While Pederson does not explicitly address the question of a culmination implicature, inherent in his analysis is that the relevant forms *start out* with a culmination entailment, which is weakened as a result of the pronounced availability of an alternative form asserting event realization. In contrast, he argues, English has a number of devices signalling lack of event realization, so there is no comparable reduction of the culmination entailment in simple forms. Pederson’s analysis is thus in opposition to many other analyses of non-culminating construals (e.g., Smith 1991; Koenig and Muansuwan 2000; Bar-El et al. 2005; Altshuler 2014), since it assumes for a semantics for such construals that excludes a non-culminating interpretation. But, more importantly, we cannot use it to explain data involving IPF_R, which is an imperfective form and does not exclude a non-culminating interpretation (indeed, some authors, like Grønn 2008, regard non-culmination as the primary interpretation of IPF_R⁷).

Bohnenmeyer and Swift’s (2004) analysis focuses on an account of telicity-dependent aspectual systems like that of German and Russian. At the heart of their analysis is a “default aspect” operator encoding event realization (i.e. culmination in the case of telic predicates), which they argue is implicated by Grice’s second maxim of Quantity:

...we submit that Grice’s (1975) second maxim of Quantity (Q2) provides the answer: “Do not make your contribution more informative than is required”; cf. also Levinson’s (2000) equivalent “I-Heuristic”, “What is expressed simply is stereotypically exemplified”. It certainly seems reasonable to consider aspectual reference under event realization more stereotypical than aspectual reference under lack of realization, and thus leave the latter to overtly marked forms. (287)

This idea is similar to what we find in Smith (1991: 87), who proposed that in the case of imperfective and neutral viewpoints, an endpoint to an ongoing situation may be inferred based on contextual and world knowledge. While the phrasing of the idea by Smith (1991) is vague, it does escape a potentially worrisome question faced by the Q2-based account of Bohnemeyer and Swift (2004), namely how exactly an aspectual operator gets “implicated”. In standard theories of conversational implicatures, it is propositions that are implicated, and we know of no accounts of conversational implicatures that implicates the addition of an operator into the LF (which is what Bohnemeyer and Swift must assume for their default aspect operator DASP). This would mean a much more involved pragmatics-semantics interaction than is generally assumed and raises questions about compositionality that would need to be addressed.

Putting such questions aside, there are further worries having to do with PFV_H. The first is that Bohnemeyer and Swift (2004) associate the default aspect operator with verbal projections that are not

⁷ See Grønn (2003) for a discussion of various takes on which interpretation of IPF_R is primary.

overtly marked for viewpoint aspect (similar to Smith’s neutral viewpoint aspect). This is not the case with PFV_H , which is overtly marked. More importantly, if PFV_H were to encode Bohnemeyer and Swift’s default aspectual operator, it would be wrongly predicted that in the case of atelics, PFV_H should function as an *imperfective*. This is clearly not the case, as the PFV_H (even under a non-culminating construal) cannot receive an “ongoing” interpretation (i.e., it cannot be used to describe non-maximal events), an option that is open for the imperfective (cf. e.g., Singh 1991: 478).

Arunachalam and Kothari (2010: 18) propose an alternative Gricean quantity-based explanation for the PFV_H . They argue that “[b]ecause full completion (telic) interpretations *entail* partial completion interpretations, the full completion interpretation is stronger, and therefore speakers may prefer it”.⁸ In what follows, we will utilize a similar heuristic in Section 4, but the lack of an explicit semantic formalization in Arunachalam and Kothari (2010; 2011) makes it difficult to gauge their predictions for different languages. We aim to couch our own account of PFV_H and IPF_R in a general theory about viewpoint aspect operators based on Altshuler 2014, and derive the required inferences for different predicates based on a reasoning from their semantics and more general principles of various kinds.

Somewhat reminiscent of Bohnemeyer and Swift’s (2004) “stereotypicality” idea discussed above, Bar-El et al. (2005) propose to derive culmination implicatures of non-culminating forms in two Salish languages with an inertia-world analysis, building on Dowty’s (1979) account of the progressive. Bar-El et al. propose that the “implicature of culmination arises because in all inertia worlds, the event culminates. In the absence of other information, the hearer assumes that the ‘normal’ course of events (culmination) takes place.” With respect to the question of why a culmination implicature is absent in the case of the English progressive (e.g., in *When I saw him, John was crossing the street*) – which has the same inertia-worlds analysis – their answer is that it is due to the presence “of a contrasting perfective form which *entails* culmination” (their emphasis).

This line of reasoning would come up against a problem in the case of PFV_H and IPF_R , both of which have a contrasting perfective form that entails culmination. Hindi has a complex verb perfective disallowing non-culminating construals (see fn. 3). Russian has a perfective (PFV_R) which, as shown in (4), leads to an entailment that the described event has culminated,⁹ unlike the IPF_R , exemplified in (5), whose culmination inference is cancellable.

- (4) a. *Ja pročital poslednie stročki pis'ma.*
 I read.PFV.PST last lines letter
 ‘I (have) read the last lines of the letter.’
 b. ... *#xotja ne pročital ix do konca.*
 even.though not read.PFV.PST them until end
 ‘... #even though I did not finish them.’
- (5) a. *Ja čital poslednie stročki pis'ma.*
 I read.IPF.PST last lines letter
 ‘I (have) read the last lines of the letter.’

⁸ Essentially the same argument is presented by Grønn (2003: Section 5.3.3) for IPF_R , who treats the culmination inference from IPF_R as pragmatic strengthening to a more specific interpretation. But while Grønn (2003: 169) needs to posit an axiom to achieve this effect, we will derive this pragmatic strengthening without case-specific axioms encoding it (see Section 4.3). Arche (2014: 805) also seems to suggest an explanation of the culmination implicature (namely of the perfective preterit in Spanish) along similar lines, proposing that “the culminated interpretation in *Marta coloreó un castillo* ‘Marta colored a castle’ may be an implicature emerging from assuming that the information provided is the maximum amount of information relevant”. However, like Arunachalam and Kothari (2010), she does not provide details of the reasoning and she also points out (806) that a differentiation between the perfective and the imperfective on her account might be in danger of being blurred.

⁹ *The Russian Academy Grammar* lists twenty-eight prefixes that can be attached to an imperfective verb to yield a perfective one and up to sixteen prefixes can be compatible with one and the same verbal stem. Here we illustrate only one such prefix, *pro-*, which always leads to a culmination entailment when combined with an imperfective verb. For other perfective prefixes, such as the delimitive prefix, *po-*, it makes no sense to talk about culmination inferences since it always yields an atelic predicate when combined with an imperfective verb. For more discussion of *po*-perfectives, see, e.g. Filip (2000; 2003), Kagan (2016) and Zinova (2017).

- b. ...*xotja* *ne pročital* *ix* *do konca*.
 even.though not read.PFV.PST them until end
 ‘...even though I did not finish them.’

Despite both PFV_H and IPF_R having a competing form entailing culmination, a culmination implicature is (at least sometimes) present in these cases, as we have seen (in (1), (2) and (5)). This presents a challenge for extending Bar-El et al.’s (2005) account to PFV_H and IPF_R , given their explanation about the lack of a culmination implicature in the English progressive.

It should be noted here that a culmination implicature is most pronounced in the case of IPF_R exactly when the use of the corresponding PFV_R is excluded, cf. Grønn (2003; 2007). Based on this observation, Grønn (2007) develops a bidirectional OT analysis in which the two aspects in Russian “compete” based on various factors. We are sympathetic to this approach – and, like Arunachalam and Kothari’s (2010) idea above, incorporate it to some extent in our own abductive account – but the fact that the exclusion of PFV_R is far from necessary for the culmination inference from IPF_R , as we have seen, is an issue for any account of the culmination implicature that requires competition.¹⁰

In sum, we agree that the defeasible inference to culmination has at its roots a pragmatic explanation. We also do not deny that competing forms play a role in the availability and strength of this inference. However, what is unique about our proposal in the next section is that our pragmatic explanation of the defeasible culmination inference does *not* require competition from other forms. Rather, it allows for any kinds of factors (including competition from alternatives) to influence the strength of the inference. In essence, an abduction-based approach is more flexible in allowing us to incorporate perhaps even on a case-by-case basis exactly those criteria that prove important for a given phenomenon. This of course means that abduction is a very *weakly constrained* tool, as we will discuss below – however, we will show that it is strong enough to make meaningful predictions. In addition, as mentioned below, abduction is a tool often used to model reasoning processes in AI, and is also argued to be an important aspect of human reasoning processes. As such, modelling a particular case of pragmatic inference – the culmination inference in our case – allows us to embed it within a more general framework that is needed on independent grounds.

3 The explanans: Abductive reasoning

3.1 Abductive inferences

In order to explain the defeasible culmination inference, we propose to exploit *abduction*, i.e., the inference to the best explanation, which is (contrary to deductive reasoning) defeasible. Abductive reasoning, suggested first by Charles Sanders Peirce, has come to be widely employed in AI (cf., e.g., Hobbs et al. 1993; for an overview, see, e.g., Josephson and Josephson 1996 or McIlraith 1998), and it is also abundantly used in everyday reasoning (cf. Douven 2011). Abduction is ideally suited for accounting for at least some defeasible inferences, but it has not yet been exploited much in formal semantics and pragmatics. An exception is Piñón (2009; 2011), who uses abduction to derive the “actuality entailments” of ability modals. In addition, Varasdi (2010; 2014) offers an analysis of the imperfective paradox via an exploitation of an inverse reasoning that is similar to abduction. Finally, Gyarmathy (2015b) has recently applied abductive reasoning to explain an existential presupposition of certain achievement predicates.

As a simple example of abduction, suppose that we observe that the street is wet and that we know that if it has been raining, then the street would be wet. We then infer (*abduce*) that it has been raining, as it is a good explanation of our observation that the street is wet. Abductive inferences often involve inference to the antecedent of a conditional on observing the consequent: if we observe q , and our theory tells us that $p \rightarrow q$, then we abduce p , because together with the theory, this entails what we observe, and is definitely at least among the simplest explanations. This is exactly the type of inference that we will exploit in the case of the culmination inference from PFV_H and IPF_R . Since an inference to the antecedent from the consequent is not

¹⁰ Grønn (2007) acknowledges that this is a problem for the framework he adopts; see also Grønn (2008: 132–133).

deductively valid, this type of inference is defeasible.

Some general constraints on a framework for abduction are as follows.

- Abduction involves:
 - O: something that is *observed* and is to be explained,
 - T: a *theory* which is the conjunction of the set of non-defeasible rules of reasoning, and
 - E: the *explanation* abduced on the basis of O and T.
- T and E together entail O,¹¹ but neither T, nor E do so alone.
- The *closed world assumption* is endorsed, i.e., we assume that our theory completely describes the relevant facts (it encodes *all possible explanations* for the observations to be true).¹²
- Reasons to regard explanation E_1 as *better* than E_2 depend on the concrete framework – not to mention their relative weights and ranks. However, the following criteria are often and widely employed, and we will use these in a descending order of importance:
 - i) E_1 is *simpler*, which in our case means ontologically more parsimonious.¹³
 - ii) E_1 is *logically stronger* or at least *more specific/presumptive*.¹⁴ The reason we treat this criterion as less important than simplicity is that it is less general, because depending on the goals of the inference process, the weaker/less presumptive explanation may instead be regarded as better (see McIlraith 1998 on examples for specific applications for abducting either the least or the most presumptive explanations).
 - iii) E_1 explains more observed facts.
 - iv) E_1 is more probable.

These and other possible criteria of ranking explanations are not necessarily independent, of course: one may entail the other, or there may be trade-offs between them. As a reviewer pointed out, logical strength and probability are inversely correlated, since if $E_1 \models E_2$ then E_2 is at least as probable as E_1 . The order of the criteria is not set into stone either: e.g., as the same reviewer noted, adults give more weight to probability than simplicity at least in some tasks involving abductive reasoning (Bonawitz and Lombrozo 2012). Later in this paper, we will briefly reflect on the specific ranking that we have chosen. For now, it is worth noting that we do not purport to exclude alternative abduction-based frameworks. We hope the analysis proposed in the next section spurs further research on how ranking for specific tasks are to be found and supported independently.

With this in mind, let us proceed to illustrate how abductive reasoning works by reconsidering the simple example noted above. Recall that we imagined a scenario in which observed that the street is wet. What do we infer from this observation? Assume that we know that if it rained, the street is wet. Moreover, assume that we know that if a water-cart passed, then the street is wet. Thus, we have two possible explanations for the street being wet: it rained, or a water-cart passed. Slightly more formally, using *rain* to designate that it rained, *watercart* that a water-cart passed, and *street_wet* that the street is wet, we have the following abductive framework:

¹¹ There are less demanding approaches to abduction, as well, in which case simple consistency with the theory suffices (McIlraith 1998).

¹² In the case of theories consisting of conditionals, Clark's completion (Clark 1978) describes the general algorithm:

(i) Assume that all the conditionals in our theory with consequent O are $E_1 \rightarrow O, \dots, E_k \rightarrow O$.

(ii) Then the definition of O , implicitly given by our theory, is $(E_1 \vee \dots \vee E_k) \leftrightarrow O$.

While our analysis of IPF_R will not consist of conditionals only, all but one of our rules can be rewritten in a generalized Horn clause language (with the single exception of $(T_{\leq 1D})$), and Clark's completion can be applied.

¹³ Other notions of simplicity that are used are, e.g., that E_1 consists of less literals, or that it is psychologically "simpler".

¹⁴ E_1 is *logically (strictly) stronger* than E_2 iff $E_1 \models E_2$ and $E_2 \not\models E_1$; E_1 is *more specific/presumptive* (with respect to theory T) than E_2 iff $T \wedge E_1 \models E_2$ and $T \wedge E_2 \not\models E_1$. However, we will use " E_1 more specific than E_2 " in a more general sense: it holds iff there exists some φ for which $\varphi \not\models E_1$ and $\varphi \not\models E_2$ and $\varphi \wedge E_1 \models E_2$, but no φ exists for which $\varphi \not\models E_1$ and $\varphi \not\models E_2$ and $\varphi \wedge E_2 \models E_1$.

1. Observation: `street_wet`
2. Theory:
 - (a) `rain` \rightarrow `street_wet`
 - (b) `watercart` \rightarrow `street_wet`
3. Explanations:
 - (a) `rain`
 - (b) `watercart`

Both `rain` and `watercart` are suitable explanations for `street_wet`, since both entail it together with the theory. This is because both are antecedents of a conditional with `street_wet` as its consequent. Now, in absence of any further criteria, there is no way to decide between `rain` and `watercart` as the *best* explanation, so what we can infer is that at least one of them holds, i.e., `rain` \vee `watercart`. Neither `rain`, nor `watercart` appears simpler than the other, and neither one is stronger than the other. However, if the street is in an area where it tends to rain several times a week, while a watercart only comes by once every month, then `rain` is much more probable than `watercart`, and is thus a better explanation in this respect.

3.2 The core semantic theory

How can we adapt abductive reasoning to the task at hand, i.e., to explaining the culmination inference of non-culminating forms? The basic idea is that there is a core semantic analysis encoding the asserted content, which provides us with the *observation* on hearing an assertion. So our observation on hearing an assertion of p is its logical form. Note that, in general, we do not aim to restrict what can be included among the observations in this way – indeed, in Section 4.3, we will consider how widening the range of observations can enable us to capture further kinds of inference. For the time being, however, we make the limiting assumption that observations only include the logical form, and show how even this simple account can explain culmination inferences, or lack thereof.

The core idea we utilize about the semantics of PFV_H and IPF_R is a distinction between *culminated* and *maximal* events with respect to an event predicate¹⁵, building on work by Filip (1999), Koenig and Muansuwan (2000), Bohnemeyer and Swift (2004), Altshuler (2014) and Martin and Gyarmathy (2017). In particular, an event e has *culminated* with respect to event predicate P iff $P(e)$ holds.¹⁶ $\text{MAX}(P)(e)$, that is, an event e is *maximal* (in the world of evaluation) with respect to event predicate P iff:

- for some possible e' of which e is a (not necessarily proper) part, $P(e')$ holds,
- and there is no event e'' in the world of evaluation such that
 - e is a proper part of e''
 - and there is some possible e' of which e'' is a (not necessarily proper) part, such that $P(e')$ holds.¹⁷

¹⁵ Cf. Zucchi (1999) for arguments why the notion of culmination has to be relativized to predicates, *pace* Parsons (1990) for whom culmination was simply a property of events. Similar arguments can be made for relativizing maximality to predicates (as do Krifka 1992, Koenig and Muansuwan 2000 and Altshuler 2014).

¹⁶ Thus, we use “culminated” in the sense of Zucchi (1999), and as synonymous with “realized” as in Bohnemeyer and Swift (2004) and Pederson (2008), to express that the event falls under the respective predicate. Since we do not discuss atelics in this paper, the term “culminated” suffices (cf. the use of the more general term “completed”, which is often used to characterize events described by atelics). We note further that while our focus here is on telic predicates, the formal analysis presented in the paper derives the correct interpretation for atelics, as well.

¹⁷ There are different possible ways of defining the notion of maximality; e.g., Koenig and Muansuwan (2000) use universal quantification over *inertia worlds* (in the sense of Dowty 1979), while Altshuler (2014) uses the notion of a “reasonable option” from Landman (1992); Altshuler also refers to maximal *stages* (using Landman’s notion of an event stage as a special kind of part) instead of maximal *parts*. However, these differences are orthogonal to the focus of this paper, and for simplicity, we just refer to “possible” events (which is, of course, insufficient in an analysis of maximal events, but nothing hinges on it in terms the arguments we put forth).

Maximal events may, but need not, have culminated. Thus, the idea is that perfectives like PFV_H that allow for non-culminating construals describe *maximal* events. On the other hand, perfectives that do not allow such readings describe *culminated* events. The Russian perfective (henceforth PFV_R) is one well-known example. As shown above in (4), PFV_R cannot be used to describe non-culminated events, whether maximal or not.¹⁸

With respect to imperfective forms, we build on Filip (1999) and endorse a distinction between imperfective forms which describe *parts* and those that describe *proper parts* of (possible) events belonging to the relevant predicate. For example, we adopt the view that the English progressive (henceforth $PROG$) is true of proper parts of (possible) events, while IPF_R is true of (not necessarily proper) parts. As such, the IPF_R , but not $PROG$, is compatible with both culminating and non-culminating construals.

Table 1 provides an overview of forms denoting different aspectual operators building on Altshuler’s (2014) typology. Note that we focus on mereological properties that we think are relevant for analyzing non-culminating construals. The columns encode whether or not the relevant form requires reference to proper parts or just parts. The rows encode whether or not the relevant form requires reference to maximal or culminated events relative to a predicate, or imposes no such requirements and simply requires reference to parts.

Table 1: A (limited) typology of aspectual forms. Forms allowing for *both* culminating and non-culminating readings are in white, while the rest of the cells are grey.

	Improper part	Proper part
Part	IPF_R	$PROG$
Maximal	PFV_H	?
Culminated	PFV_R	–

As can be seen in Table 1, aspectual forms that allow for both culminated and non-culminating readings are those which describe parts that are not necessarily proper. This semantic analysis, then, supplies the *observations* for our abductive framework. For example, an assertion of $PFV_R(P)$ leads us to the observation that there is a culminated P -event in the world of evaluation.

The *theory* of our abductive framework encodes general principles, which in our case will mostly feature general principles of mereology and mereological principles relating to predicates. These are in a conditional form, and some of them will include the relevant observation as its consequent. Therefore, the antecedents of these conditionals will be possible explanations for the relevant sentence to be true, and we will infer the best explanation among these. Thus, on this approach, the culmination inference is, in a way, an “educated guess” based on the theory and the core semantic analysis.

In order to describe the rules of our theory, let us introduce *actualist* and *possibilist quantifiers* over events (cf., e.g., Prior and Fine 1977). The actualist quantifiers $\exists_{@}$ and $\forall_{@}$ quantify over events occurring in the actual world (the world of evaluation).

- (6) $\exists_{@}e(P(e))$ stands for “there is an actual P -event” and is true at the world of evaluation w_0 just in case there is an event in w_0 which belongs to the denotation of P at w_0 .
- (7) $\forall_{@}e(P(e))$ stands for “all actual events are P -events” and is true at the world of evaluation w_0 just in case all events in w_0 belong to the denotation of P at w_0 .

The possibilist quantifiers \exists_{\Diamond} and \forall_{\Diamond} quantify over possible events.¹⁹

¹⁸ As noted by an anonymous reviewer, one may reject this generalization by pointing out that the delimitive perfective prefix *po-* never leads to a culmination inference in Russian. However, as noted in fn. 9, *po-*perfectives are atelic and hence it makes no sense to talk about culmination inferences with respect to *po-*perfectives.

¹⁹ For simplicity, we here assume a basic possible worlds semantics, where necessary propositions are true at all possible worlds; see also fn. 17.

- (8) $\exists_{\Diamond}e(P(e))$ stands for “there is a possible P -event” and is true at the world of evaluation w_0 just in case there is an event in some possible world w which belongs to the denotation of P at w .
- (9) $\forall_{\Diamond}e(P(e))$ stands for “all possible events are P -events” and is true at the world of evaluation w_0 just in case $\neg\exists_{\Diamond}e\neg(P(e))$ is true at w_0 , that is, just in case at all possible worlds w , all events belong to the denotation of P at w .

Now we can turn to the conditionals that are the relevant rules from our theory. First, we have mereological principles as non-defeasible rules based on the definitions of culminated and maximal events, and the usual notions of the proper part-of and (non-strict) part-of relations. Let \sqsubset be the usual “proper part of” and \sqsubseteq the “part of” relation on the set of events.²⁰

- (10) $\text{MAX}(P)(e)$, as noted above, stands for “ e is a maximal actual part of a possible P -event”. That is, $\text{MAX}(P)(e)$ iff $\exists_{\Diamond}e'[e \sqsubseteq e' \wedge P(e')] \wedge \neg\exists_{\@}e''[e \sqsubset e'' \wedge \exists_{\Diamond}e'(e'' \sqsubseteq e' \wedge P(e'))]$.
- (11) $\text{PRPART}(P)(e)$, in analogy, stands for “ e is an actual proper part of a possible P -event”. That is, $\text{PRPART}(P)(e)$ iff $\exists_{\Diamond}e'(e \sqsubset e' \wedge P(e'))$.
- (12) $\text{PART}(P)(e)$ stands for “ e is an actual (not necessarily proper) part of a possible P -event”. That is, $\text{PART}(P)(e)$ iff $\exists_{\Diamond}e'(e \sqsubseteq e' \wedge P(e'))$.

The following conditionals are then part of our theory:

- (Ia) $\exists_{\@}e(P(e)) \rightarrow \exists_{\@}e(\text{PART}(P)(e))$
- (Ib) $\exists_{\@}e(P(e)) \rightarrow \exists_{\@}e(\text{MAX}(P)(e))$
- (Ic) $\exists_{\@}e(\text{PRPART}(P)(e)) \rightarrow \exists_{\@}e(\text{PART}(P)(e))$
- (Id) $\exists_{\@}e(\text{PRPART}(P)(e)) \rightarrow \exists_{\@}e(\text{MAX}(P)(e))$

(Ia) is true because of the reflexivity of the part-of relation: all events that are culminated are parts of themselves. (Ib) holds for a telic predicate P , because all events that have culminated are necessarily maximal parts, as an event cannot develop (as a P -event) beyond its culmination. Therefore, given the occurrence of a culminated event, we get *a fortiori* the occurrence of a maximal event. (Ib) also holds for atelic predicates, as it is a standard assumption that all sets of events have a join, and the join of a set of P -events in a given situation is the maximal event (and part) in that situation (cf. Filip 2008). (Ic) is true because the part-of relation is a superset of the proper part-of relation, and (Id) is true based on the same reasoning as the one for (Ib) for atelics.

In addition, our theory includes some standard assumptions based on Vendler (1957) about the part-structure of events belonging to the classes of achievements and accomplishments (cf. also Dowty 1979; Krifka 1989; 1992):

- (IIa) $\text{ACCOMPLISHMENT}(P) \rightarrow \forall_{\@}e(P(e) \rightarrow \exists_{\@}e'(e' \sqsubset e))$
- (IIb) $\text{ACHIEVEMENT}(P) \rightarrow \forall_{\@}e(P(e) \rightarrow \neg\exists_{\@}e'(e' \sqsubset e))$

These principles encode the idea that accomplishments, but not achievements, describe temporally extended events, i.e., have proper parts.

In what follows, we offer an abductive account of the culmination implicature, where the theoretical premises in our account appeal to the general principles in (I)–(II) and the core semantics of various aspectual forms is assumed to be as outlined in Table 1.

²⁰ \sqsubseteq is the union of the \sqsubset relation and the identity relation; while \sqsubset is an irreflexive partial order, \sqsubseteq is a reflexive partial order.

4 Applying abduction to non-culminating cases

4.1 Abduction and the culmination inference in Hindi

We assume, based on Altshuler (2014), that a Hindi perfective accomplishment P applies to an event e just in case e is the maximal realized part in the world of interpretation of a possible P -event (cf. Table 1). So assume that a sentence containing a predicate P in the PFV_H is asserted. The asserted content of this sentence will be the “observation” in terms of abductive reasoning. Recall that an abductive inference often involves inferring the antecedent of a conditional after observing the consequent, so we will need to construct an argument which involves a conditional whose consequent is this asserted content. In particular, we can have the following abductive reasoning:²¹

1. Observation:

$$(O_H) \quad \exists_{@} e (\text{MAX}(P)(e))$$

2. Theory:

$$(T_H) \quad \exists_{@} e (P(e)) \rightarrow \exists_{@} e (\text{MAX}(P)(e))$$

3. Explanation for the observed facts (abduced):

$$(E_H) \quad \exists_{@} e (P(e))$$

The observed fact is simply the asserted content of the sentence including a PFV_H, which asserts the occurrence of a maximal part of a possible P -event.²² (T_H) encodes the non-defeasible inference from a culminated event to a maximal part that is our general principle (Ib), discussed in the previous section. Based on our theory, the occurrence of a culminated event is a possible explanation of the observation.

The reasoning above turns crucially on the background theory which the abductive procedure makes use of. This prompts the question whether another explanation could perform just as well. While this is a question which is very hard to answer in the general case, let us look at another plausible candidate for the role of explanation, based on our general principle (Id), reproduced here as $(T_{H\sqsubset})$. Note that since $(E_{H\sqsubset}) \wedge (T_{H\sqsubset})$ entails the observation, $(E_{H\sqsubset})$ is an admissible explanation (albeit the incorrect one).

$$(T_{H\sqsubset}) \quad \exists_{@} e (\text{PRPART}(P)(e)) \rightarrow \exists_{@} e (\text{MAX}(P)(e))$$

$$(E_{H\sqsubset}) \quad \exists_{@} e (\text{PRPART}(P)(e))$$

Recall that abduction is the inference to the *best* explanation, which means that it does not preclude the existence of alternative explanations. (Indeed, this is exactly what guarantees the non-monotonicity of this reasoning process.) So what remains to be done in order to get a culmination inference for PFV_H is to show

²¹ A note on the notation of labels: Observations are labelled “O”, non-defeasible rules in our theory “T” and explanations “E”. These are subscripted with language tags: “H” for Hindi, “R” for Russian, “E” for English. Finally, \sqsubset is used to designate rules and explanations which revolve around proper parts rather than culminated events.

²² For simplicity, we here disregard any temporal constraints the perfective (and other aspectual forms) may additionally impose and use simple existential quantification over events (see Altshuler 2016: Ch. 6 for discussion). This is actually a non-trivial simplification, because, among others, it masks the difference between two kinds of culmination inference: we can infer that the event of which the relevant verbal predicate is true is a culminated event (which is the culmination inference from PFV_H and IPF_R that we are interested in), but we can also infer that there is (either before the reference time or at any time in the world of evaluation) a culminated event of the relevant kind. Because ontological parsimony favours the first inference, this simplification will not be detrimental in our case, but a more detailed description of the semantics and thus the inference process is important for future research. In the case of IPF_R, we could, for example, use the temporal calculus described by Grønn (2003) to arrive a more detailed model of the inferences we derive.

why the existence of a culminated P event is the best explanation for the existence of a maximal part of a possible P -event. As mentioned above, what counts as “best” depends on the concrete framework of abduction, but simplicity, strength and coverage are often used as criteria in selecting best explanations (McIlraith 1998; Hobbs 2004).

While the rule in $(T_{H\sqsubset})$ above can be applied in the case of accomplishments, it is *vacuously* true (and hence of no explanatory value) in the case of achievements. The reason for this is that in the case of achievements, the antecedent (“there is a proper part of a possible P -event”) is necessarily false, since achievements have no proper parts (cf. (IIb)). Thus, $(E_{H\sqsubset})$ cannot be abduced in the case of achievements, so it has a worse coverage than (E_H) . Thus, (E_H) is the best explanation.²³

Also, whenever an event *does* have proper parts, (E_H) (“There is a culminated P -event”) entails $(E_{H\sqsubset})$ (“There is a proper part of a possible P -event”), while the reverse does not hold. Therefore, (E_H) is the *most specific* explanation (cf. Section 3.1). Since in several abduction frameworks (e.g., those used in diagnosis), the preferred explanation that is abduced is the “most specific” one (McIlraith 1998), (E_H) is again the best explanation of the two candidates.

Note that the choice of what counts as a “better” explanation (in our case, (E_H) is better than $(E_{H\sqsubset})$) is not circular: it is decided in a particular model of abduction via a set of (either unordered, or, as in our case, ordered) criteria. Once the criteria of what counts as a better explanation are fixed, the abductive reasoning process allows no deviation from it.

In the case of accomplishments, our abductive reasoning provides us with the required culmination inference: we do infer culmination (via abduction), but this inference is defeasible (since we arrived at it via non-monotonic reasoning). In the case of achievements, as noted by Altshuler (2014), this inference is not cancellable, because they do not have proper parts: if what we observe is the existence of a maximal part of a possible event falling under the achievement predicate P , then we observe the P -event itself, since no P -events for any achievement P have proper parts. Thus, the existence of a culminated event in the case of achievement is not *abduced*; it is *entailed* by the observation. Thus, without any reference to competing forms, but given solely the semantics of PFV_H , abductive reasoning can derive the required patterns:

- Accomplishments have a culmination implicature (but not entailment).
- Achievements have a (non-cancellable) culmination entailment.

Toward more complex accounts

Before we move on to an abduction-based account of culmination inferences for the Russian imperfective, it is worth revisiting some deliberate simplifying assumptions that we made above.

First, in order for the correct culmination inference to come out as the best explanation, we have exploited the preference for specific explanations in determining what counts as a better explanation. However, as noted in Section 3.1, the criteria determining the goodness of an explanation and their relative weights are open for debate.²⁴ In fact, it is conceivable that the criteria and their ranking could be learned and fine-tuned based on the success of inferences made by agents (or algorithms). As such, we reiterate that one should approach our specific ranking with a critical eye, and explore where some alternative criteria and/or ranking would lead.

²³ More precisely, (E_H) is the best at least among these two explanations. But other explanations that do not use (T_H) would intuitively be less simple, e.g., contain more conjuncts in the antecedent of rules, and so (E_H) would still be the best explanation.

²⁴ From a cognitive perspective, these criteria can only be determined indirectly through pragmatic behavior and reasoning, and might even conceivably vary inter- or even intra-personally, or from task to task. In fact, a body of experimental research has already shown that pragmatic inference patterns in general are far from stable across speakers (the most marked contrast being between literal and pragmatic speakers), and also that they change substantially from early childhood to adulthood. Most recently, Martin et al. (2018) observed a difference in pragmatic behavior between children and adults in the interpretation of telic sentences in different languages: children either over- or under-generate non-culminating interpretations (depending on the aspectual system of the language). This may be indicative of a change in strategies in abduction over the lifetime of a person (cf. also Bonawitz and Lombrozo 2012). And from a computational point of view, different tasks can certainly necessitate different criteria for abductive algorithms (McIlraith 1998), as noted in Section 3.1.

For instance, if probable explanations were to get top priority, then a whole new set of questions would open up, first and foremost, to do with the level of generality we should employ in our reasoning process. To see this, suppose we restrict our attention to a specific predicate, say, **eat-a-cake**, or to some specific subset of predicates, say, accomplishments. It is then straightforward to decide whether (E_H) or $(E_{H\sqsubset})$ is the more probable explanation. Due to (IIa), the occurrence of proper parts $(E_{H\sqsubset})$ must have at least as high a relative frequency as that of complete events (E_H) . But at more general levels, taking all predicates into account (including achievements and atelics), the picture is less clear.

Since we have made the limiting assumption that the observation is, simply, the logical form, if the sentence was about cake-eating, then the observation includes information about cake-eating. At the same time, one of our arguments above rested on the fact that the general form of $(T_{H\sqsubset})$ is vacuously true for achievement predicates, which degrades the goodness of the corresponding explanation. While not pertinent to cake-eating, the potential of a rule or explanation to generalize to other cases weighs in favor of it. Nevertheless, we may ask why the observation or the theory does not include contextual (perceptual, discourse, etc.) information, world knowledge or meta-level information (e.g., that **eat-a-cake** is an accomplishment). Our answer is that there is no reason they should not. Indeed, in Section 4.2, we will see how world knowledge can influence the reasoning process, and in Section 4.3 we explore some possibilities that reasoning about meta-level information opens up. However, including, for example, explicit aspectual class information in our reasoning about PFV_H would not affect the outcome (since as we have seen, specificity renders (E_H) the winner for accomplishments), and would only complicate the exposition.

Our aim in this paper, in general, is not to explore all the complex possibilities of alternative abductive accounts, but to offer a proof of concept that abduction can be a valid approach to semantic-pragmatic phenomena. For this reason, we try to keep the argumentation as simple as possible, making some limiting assumptions (about criteria for explanation goodness or the content of the observation) that may be relaxed for more complex analyses or even become the subject of a new study. Indeed, as mentioned before, we would welcome further alternative abduction-based proposals for the phenomena under scrutiny here or for other semantic-pragmatic inferences.

4.2 Russian imperfective

Our proposed abductive reasoning deriving the defeasible culmination inference in Hindi cannot be directly adopted for the Russian imperfective, which (as an imperfective) does not involve maximalization. As such, the observed facts in the case of sentences involving IPF_R are different. But the proposed inference only needs to be modified slightly. Following Altshuler (2014), we assume that, informally, the Russian imperfective is true of a predicate P and event e , just in case e is a (neither necessarily maximal, nor necessarily proper) part of a possible event e' to which P applies (cf. Table 1). Given this assumption, the existence of a culminated event is not the *only* explanation for the observed facts (i.e., the asserted content). Nevertheless, just as in Hindi, we can argue that it is the best one.

In particular, if a sentence with $\text{IPF}_R(P)$ is asserted to be true, then we can construct the following abductive inferences:

1. Observation:

$$(O_R) \quad \exists_{@} e (\text{PART}(P)(e))$$

2. Theory:

$$(T_R) \quad \exists_{@} e (P(e)) \rightarrow \exists_{@} e (\text{PART}(P)(e))$$

$$(T_{R\sqsubset}) \quad \exists_{@} e (\text{PRPART}(P)(e)) \rightarrow \exists_{@} e (\text{PART}(P)(e))$$

3. Explanations:

$$(E_R) \quad \exists_{@} e (P(e))$$

$$(E_{R\sqsubset}) \quad \exists_{@} e (\text{PRPART}(P)(e))$$

Just as in the case of Hindi, we need to ascertain which of the explanations the best one is. And, just as in the case of PFV_H , reasons to favor (E_R) is that it has better coverage, and is more specific than its alternative $(E_{R\sqsubset})$ (for the same reason (E_H) has better coverage and is more specific than its alternative). Thus, even in the case of the Russian imperfective, we can use abduction to derive a (defeasible) culmination inference.

A non-minimal context

Importantly, the abduction of the culmination inference hinges on the fact that the only observation is (O_R) , and there are no relevant blocking observations – where a relevant blocking observation is one which affects the outcome of the reasoning in the sense that it precludes inferring the explanation abduced for the minimal observation.²⁵ We will see that once other relevant observations come into the picture, we might arrive at a different result. This is why we said in Section 1 that we restrict our attention to “minimal contexts”. We can now specify this notion more closely: a minimal context only provides us with the minimal observation (in our case, (O_R)), and nothing else.

Let us take an example with a non-minimal observation:

- (13) *Včera ja čítal “Vojnu i Mir”.*
yesterday I read.PST.IPF “War and Peace”
‘Yesterday I was reading “War and Peace”.’

In this case, there is no implicature of culmination: the most natural reading of (13) is one of non-culmination. The reason for this is evident, and perspicuously expressed by Grønn (2003: 171): “if the interval of the assertion time is ‘small’ compared to what would constitute the normal length of the temporal trace of the event, we get a processual reading”. Grønn (2003: 171) posits a dedicated axiom to ensure that a processual (ongoing) reading is inferred whenever the assertion time is relatively small. We now proceed to show that we can also achieve this result, without stipulating a dedicated axiom, once we acknowledge that (13) contains particular observations worthy of consideration – observations that are distinct from the minimal observation in (O_R) above.

Given the semantics of a temporal modifier like *včera* ‘yesterday’, part of the semantic representation of (13) is that there is an event e such that $IPF_R(\text{read-War-and-Peace})$ is true of e and the temporal trace of e is part of yesterday ($\tau(e) \subseteq \text{yesterday}$), from which we can infer that it is shorter than one day ($|\tau(e)| \leq 1 \text{ day}$; here, “shorter” stands for “shorter or equal to”). Given world knowledge, we know that a culminated event of reading “War and Peace” is longer than 1 day. With this in mind, let us now look at: (i) our observation (the relevant parts thereof), (ii) the relevant rules from our theory and, (iii) *potential* explanations with $W\mathcal{E}P$ standing for the predicate *read “War and Peace” (completely)*.

1. Observation:

$$(O_{(13)}) \quad \exists_{@} e (\text{PART}(W\mathcal{E}P)(e) \wedge |\tau(e)| \leq 1 \text{ day})$$

2. Theory:

$$(T_{W\mathcal{E}P}) \quad \exists_{@} e (W\mathcal{E}P(e)) \rightarrow \exists_{@} e (\text{PART}(W\mathcal{E}P)(e))$$

$$(T_{W\mathcal{E}P\sqsubset}) \quad \exists_{@} e (\text{PRPART}(W\mathcal{E}P)(e)) \rightarrow \exists_{@} e (\text{PART}(W\mathcal{E}P)(e))$$

$$(T_{\sqsubseteq\leq}) \quad \forall e \forall e' (e \sqsubseteq e' \rightarrow |\tau(e)| \leq |\tau(e')|)$$

$$(T_{\leq 1D}) \quad \forall_{@} e \exists_{@} e' (e' \sqsubseteq e \wedge |\tau(e')| \leq 1 \text{ day})$$

$$(T_{W\mathcal{E}P > 1D}) \quad \forall e (W\mathcal{E}P(e) \rightarrow |\tau(e)| > 1 \text{ day})$$

²⁵ If given the minimal observation O_M we abduce E_M , then O_R is a relevant blocking observation if it blocks the abduction of E_M , i.e., given $O_M \wedge O_R$, we do not abduce $E_M \wedge \varphi$ for any φ .

3. Potential explanations:

$$(E_{(13)>}) \quad \exists_{@} e (W\mathcal{E}P(e) \wedge |\tau(e)| > 1 \text{ day})$$

$$(E_{(13)\leq}) \quad \exists_{@} e (W\mathcal{E}P(e) \wedge |\tau(e)| \leq 1 \text{ day})$$

$$(E_{(13)\sqsupset>}) \quad \exists_{@} e (\text{PRPART}(W\mathcal{E}P)(e) \wedge |\tau(e)| > 1 \text{ day})$$

$$(E_{(13)\sqsupset\leq}) \quad \exists_{@} e (\text{PRPART}(W\mathcal{E}P)(e) \wedge |\tau(e)| \leq 1 \text{ day})$$

$(E_{(13)\leq})$ must be rejected, because it contradicts the theory (in particular, the rule $(T_{W\mathcal{E}P>1D})$). $(E_{(13)>})$ and $(E_{(13)\sqsupset>})$ are acceptable explanations, because the observation can be derived from them.²⁶ $(E_{(13)\sqsupset\leq})$ is also an acceptable explanation for the same reason.²⁷ However, we would also infer that the actual event in the explanation and the observed event are not the same events in the case of $(E_{(13)>})$ and $(E_{(13)\sqsupset>})$ because no event can be both shorter and longer than 1 day. Therefore, these explanations would force us to assume more events than $(E_{(13)\sqsupset\leq})$. While $(E_{(13)>})$ and $(E_{(13)\sqsupset>})$ are more specific than $(E_{(13)\sqsupset\leq})$, given ontological parsimony as a more important factor in deciding among explanations than specificity,²⁸ $(E_{(13)\sqsupset\leq})$ is the best explanation. Hence, in the case of (13), we correctly predict that culmination is not inferred from the IPF_R form – in contrast to minimal context cases like (2) that are characterized by a culmination inference.²⁹

At this point, the reader might worry that the same abductive reasoning as we put forth in the case of the minimal observation (O_R) above may incorrectly generalize to other aspectual forms like PROG, which does not give rise to a culmination implication. While both PROG and IPF_R are special cases of a general imperfective (Comrie 1976), their semantics are different (cf. Section 3.2). In fact, there are a number of different partitive operators (cf. Altshuler 2014; Martin and Gyarmathy 2017), and for different operators, abductive reasoning will proceed differently because of their different semantics (cf. the differences between the Hindi PFV_H and the Russian IPF_R). And as will be shown in Section 4.4, given the semantics of the PROG, an abductive inference to culmination cannot go through. Before discussing PROG, however, let us first consider external factors in deriving the culmination inference with IPF_R , namely contexts which are incompatible with the PFV_R .

4.3 Factoring in external factors

It has been observed that a culmination inference from IPF_R is very much (though not completely) dependent on context and whether or not the corresponding PFV_R would or would not be felicitous in that particular context (Grønn 2003; 2007; Altshuler 2014). This may seem at odds with our proposed analysis, where reference to PFV_R is not necessary to derive the culmination inference with IPF_R . However, as noted earlier, abduction allows for any number of factors to influence the best explanation in a given case.

In fact, by taking Hobbs et al.’s (1993) and Hobbs’s (2004) approach of viewing implicatures as abductive inferences, we can account for the tendency of PFV_R to be dispreferred in those contexts where IPF_R gives rise to a culmination inference. While we have thus far only taken “facts about the world” into consideration in our abductive reasoning, adding “facts about the conversation” allows us to make more nuanced predictions about what speakers will infer and when.

Indeed, as argued independently by Gyarmathy (2015b), this is a necessary step in using an abductive approach to semantic-pragmatic phenomena. The reason for this is that it prevents us from incorrectly making inferences, e.g., from *some* to *all*. As explained by Gyarmathy (2015b: 174):

²⁶ The derivation goes via $(T_{\leq 1D})$ (and the transitivity of the part-of relation for $(E_{(13)\sqsupset>})$).

²⁷ The derivation goes via $(T_{W\mathcal{E}P\sqsupset})$ and $(T_{\sqsupset\leq})$.

²⁸ This is so, given that there is no general case to be made for choosing the more or the less specific explanation in abduction, see Section 3.1.

²⁹ This is in line with Grønn’s observation that “pragmatic strengthening of IpF [i.e., culmination inference from IPF_R] will always occur in a non-ambiguous context” (Grønn 2003: 169).

[S]uppose that, by vast majority, whenever someone eats some apples, they eat all (of a bunch). In this case, from the observation that *x* ate some apples, we would abduce that they ate all, quite contrary to the scalar implicature of *some*. However, note that this inference would be based on reasoning solely about facts of the world. Taking into account additional facts, in particular that someone uttered *x ate some apples*, and extending our theory with the cooperative principles of conversation, we would now cancel our original inference (that *x* ate every apple) and abduce its opposite, that *x* in fact did *not* eat every apple. This (as Károly Varasdi, p.c., noted) highlights the importance of the *non-monotonicity* of abductive reasoning, that is, that abductive inferences are defeasible when information is added.

Note that we would want the inference from *some* to *all* in this scenario to go through when, e.g., we only consider information randomly supplied by a computer about a situation; i.e., when we only reason about facts of the world, and not about facts of the world and the utterances about them.

Past tense inference from St'át'imcets perfectives

Before turning to culmination inferences in Russian, let us consider an example of how abduction can handle some Gricean inferences pertaining to aspect. Bar-El et al. (2005) note that St'át'imcets perfective accomplishments generally have past tense reference. This past tense reference, however, is a defeasible inference, as shown in their example below by the availability of a present interpretation of (14):

- (14) *máys-en-as ta káoh-a kw-s Bill*
 fix-TR-3ERG DET car-DET DET-NOM Bill
 OK: 'Bill is fixing the car.'

Bar-El et al. explain the past inference as a conversational implicature: the preferred interpretation of a perfective accomplishment sentence is in the past, because there is a competing form, namely, the imperfective, which is a better way to express a present imperfective interpretation. They illustrate this contrast with the following pair of examples:

- (15) a. *máys-en-lhkan ta káoh-a*
 fix-TR-1SG.SU DET car-DET
 Default interpretation: 'I fixed the car.'
 b. *wá7-lhkan máys-en ta káoh-a*
 IPF-1SG.SU fix-TR DET car-DET
 'I'm fixing the car.'

Bar-El et al.'s explanation can be implemented in our abductive framework as follows. The observation is that a perfective form was uttered:

(O_{PFV}) The speaker uses PFV

Our framework encodes that the perfective can be used to describe both past and present events, whereas the imperfective can only be used to describe present events:

(T_{PFV}) present event \rightarrow (The speaker uses PFV \vee The speaker uses IPF)

(T_{IPF}) past event \rightarrow The speaker uses PFV

On the basis of this theory, the only possible explanation we can abduce for the observation that speaker uses PFV is **past event**; **present event** and the theory do *not* entail the observation (since the disjunction "The speaker uses PFV \vee The speaker uses IPF" does not entail its disjuncts). So the explanation we abduce for the observation that the speaker uses PFV is that a past event is being described. But since, again, we infer the antecedent of a conditional based on its consequent, this inference is not predicted to be logically valid – and so the existence of examples like (14) do not undermine the inference from the PFV to the past.

In sum, we hope this exercise has illustrated that abductive reasoning can derive the following Gricean idea: if there are two alternative expressions with a more general and a more specific meaning, respectively, cooperative speakers should use the more general expression to describe specific cases not covered by the specific expression – barring other factors. On the other hand, if other factors (such as simplicity of expression

and economy) do come into play, those will also enter into the observation and there will be more relevant rules in our theory. And in that case, the abductive inference process will proceed differently.

An important consequence of our analysis is that we expect other aspectual forms to be a key factor for whether a sentence – which, in principle, allows for both a culmination and a non-culmination inference – has a culmination inference. If there is an alternative form (of a commensurable complexity) that leads to a culmination entailment, we expect a culmination inference only if the alternative form is ruled out for some reason. This is what we now show for the Russian imperfective.

The case of the Russian IPF_R

Taking into account facts of conversation, the best explanation for *hearing/uttering* a Russian sentence with IPF_R will include the fact that the corresponding PFV_R would have been more misleading in conveying the relevant facts of the world. Reasons for this may be multifarious, as argued by Altshuler (2014); the perfective may simply be false, or, e.g., it would lead to a less coherent discourse.

Let us work through one concrete example. Take the following pair of perfective and imperfective sentences from Altshuler (2014):

- (16) a. *Ja otkry-l okno.*
 I PFV.open-PST window
 ‘I (have) opened the window.’
 b. *Ja otkr-yva-l okno.*
 I open-IPF-PST window
 ‘I (have) opened the window.’

As Altshuler notes, only (16b) would be a felicitous response to the question *Why is it so cold in here?* in a context where all the windows are closed. The reason for this is that (16a) has a *result perfect* interpretation, and so has the additional inference that the window is open at the speech time.³⁰

In this case, we want to reason about what sentence the speaker should use to convey that the window has been opened (P), while it is currently closed (the result state thereof does not hold, i.e., $\neg \text{RES}(P)$). (As such, the abductive process is now concerned not with drawing some additional inference from facts gleaned from an assertion, but about finding the optimal form to express some facts.³¹) Let this be the observation, and then the abduced, best “explanation” would be the best form for the speaker to use in this case.

$$(O_{\text{okno}}) \quad \exists_{\text{@}} e(P(e)) \wedge \neg \text{RES}(P)$$

Our theory tells us that an assertion with PFV_R ($\text{Assert}(\text{PFV}_R(P))$) leads to a result perfect interpretation, while IPF_R is neutral between a culminating and non-culminating interpretation, simply referring to parts:

$$(T_{\text{PFV}_R}) \quad \text{Assert}(\text{PFV}_R(P)) \rightarrow \left(\exists_{\text{@}} e(P(e)) \wedge \text{RES}(P) \right)$$

$$(T_{\text{IPF}_R}) \quad \text{Assert}(\text{IPF}_R(P)) \rightarrow \left(\exists_{\text{@}} e(\text{PART}(P)(e')) \right)$$

Clearly, $\text{Assert}(\text{PFV}_R(P))$ (i.e., asserting the perfective form) not only fails to explain the observation, it also contradicts it. Hence, assuming that our theory is complete with respect to possible explanations of the observation, the best way to explain the observation is $\text{Assert}(\text{IPF}_R(P)) \wedge \neg \text{RES}(P)$. So IPF_R(P), but not PFV_R(P), can be asserted in this scenario.

Moreover, since PFV_R(P) is ruled out in this case, IPF_R(P) will not receive the specific interpretation that is not covered by PFV_R (i.e., a non-culminating construal) even though IPF_R is more general than PFV_R with respect to culmination. And if its interpretation is not restricted in this way (as opposed to cases where the PFV_R is not ruled out), it is expected to have a culmination inference via the reasoning in Section 4.2.

³⁰ The idea that the perfective/imperfective contrast in Russian is, in part, analogous to the contrast between the result/experiential perfect in English goes back to Hulanicki (1973).

³¹ Note that we here do not differentiate between the perspectives of the hearer and the speaker, although this would be theoretically also possible. One could fine-tune the abductive system to include different theories and perhaps even different criteria of what explanation counts as better for speakers and hearers. The abductive reasoning process is orthogonal to this question, as it only concerns *how* some defeasible inference is derived.

4.4 On the danger of overgeneralization

A worry that may arise for our analysis is that it is too powerful. For instance, recall the fact that the inference to culmination in the case of PFV_R is not cancellable, like it is with PFV_H , cf. (4) above. Having motivated a particular analysis for PFV_H , does this mean that we get things wrong for PFV_R ?

As mentioned in Section 3.2, we believe that the difference between PFV_H and PFV_R boils down to the semantics of these two forms. Recall that, as argued for by Altshuler (2014): if $\text{PFV}_R(P)$ is true of an event e , what is observed is that e is *culminated* – and not, as in Hindi, that it is a maximal part (cf. Table 1). So the entailment of culmination from a PFV_R form can be derived even in an analysis that relies on a tool that is as powerful as abduction: anything that is part of the semantics (i.e., what is “observed”, in terms of abductive reasoning here) is not cancellable. Since culmination is part of the semantics of the perfective in Russian (but not in Hindi, or Tamil, or Thai, or Mandarin Chinese), culmination is entailed, rather than a defeasible inference.

A similar worry may arise with respect to whether our analysis of IPF_R makes incorrect predictions for PROG. Why don’t we have a culmination inference in the case of PROG by constructing a similar abductive reasoning that we did for IPF_R in Section 4.2? Again, what prevents such an inference is the semantics of PROG. In particular, as argued by Altshuler (2014), the main difference between the Russian imperfective and the English progressive is that IPF_R requires the existence of a *part* (of a possible event of the given kind), while PROG requires the existence of a *proper part* (of a possible event of the given kind). That means that given a progressive sentence $\text{PROG}(P)$ in English, the semantics of the construction provides us with the following observation:

$$(O_E) \quad \exists_{@} e (\text{PrPART}(P)(e))$$

In order for abductive reasoning to go through, our theory would need to contain a conditional that has this observation as its consequent, and a clause asserting the existence of a culminated P -event as its antecedent:

$$(T_E) \quad \exists_{@} e (P(e)) \rightarrow \exists_{@} e (\text{PrPART}(P)(e))$$

However, (T_E) is crucially *not* an acceptable, non-defeasible rule in our theory. In particular, events falling under achievement predicates do not have proper parts, and so the antecedent of (T_E) can be true (there is a culminated P -event for some achievement predicate P), but the consequent false (there is no proper part of a possible P -event, since P -events have no proper parts). Thus, (T_E) must be rejected as being part of our theory. Therefore, the abductive reasoning constructed for IPF_R cannot go through for PROG. And so, quite correctly, no culmination inference is expected in the case of English progressives.³²

In sum, the danger of overgeneralization is a valid worry about abduction. However, we hope to have shown that the semantics of natural language expressions, along with facts of the conversation, provide enough restriction on the inference process to prevent us from drawing the same inferences all the time. In particular, we hope to have shown that an abductive system has the predictive power to explain why the defeasible culmination inference sometimes, but not always, arises.

5 The status of inferences

While researchers on non-culminating construals have uniformly assumed that the defeasible culmination inference from PFV_H and IPF_R is an implicature, our abductive analysis raises the possibility that this

³² It is worth noting here that Asher’s (1992) theory of the progressive is based on the idea that a progressive implies that a culmination would normally be reached. However, even on Asher’s approach, only a *future* culmination is inferred from PROG, in contrast to the culmination inference from PFV_H and IPF_R . As noted in fn. 22, once we incorporate temporal information into our account, we hope to be able to model this distinction, and then derive the correct inferences for various aspectual forms.

inference may also be of a different kind. Indeed, in AI, abduction has been used in widely differing areas, e.g. syntactic tasks, establishment of coherence relations (cf., e.g., Hobbs 2004 for an overview) and even testing the definitional adequacy of coherence relations (Altshuler and Varasdi 2015, Altshuler 2016: Ch. 3). As such, the status of the abduced explanation can be quite wide-ranging.

The question of the status of the culmination inference may be particularly pertinent given recent studies by Gyarmathy (2015a;b), who argues that there are *presuppositions*, distinct from implicatures, that are cancellable in unembedded contexts. In particular, an inference to the occurrence of a preliminary process of right-boundary achievements (in the terminology of Piñón 1997; henceforth RB-achievements) is cancellable even when the achievement predicate is not embedded under any operators. For example, in (17) below (cited by Gyarmathy 2015b), the process-presupposition of *arrive at your destination*, namely *move toward your destination*, is cancelled.

- (17) [...] you can curve space in such a way that you “pull” your destination towards you and restore space once you are at the apex of the curvature, having effectively **arrived at your destination** without moving.

To explain the cancellable inference, the following abductive process can be constructed:

1. Observation:

(O_A) There is an event belonging to RB-achievement P (e.g., arrival).

2. Theory:

(T_A) If there is an extended event of type Q (e.g., movement to the goal),
then there is an event belonging to RB-achievement P (e.g., arrival).

3. Explanation for observed facts (abduced):

(E_A) There is an extended event of type Q (e.g., movement to the goal).

4. Fact deduced from the explanation:

(Proc) There is a process of type Q' (e.g., movement towards the goal).

The idea behind this reasoning is that extended events belonging to the extension of accomplishments (here, predicate Q) are composed of a process belonging to a given process type (here, Q') and a culmination belonging to some RB-achievement predicate (here, P). Thus, from the existence of a P -event, we can abduce the existence of a Q -event, from which we can deduce the existence of a Q' -event, i.e., a preliminary process to the culmination. This way, the inference to the occurrence of a preliminary process is correctly expected to be defeasible. Crucially, however, Gyarmathy (2015b) argues that the inference to a preliminary process from RB-achievements is a presupposition rather than an implicature on the basis of, among others, its projection behavior, and in terms of its at-issueness. This conclusion leads us to wonder whether the culmination inferences that we have explained via abduction in this paper are implicatures, as has been assumed thus far, or if they are of some different kind of implied content.

Unfortunately, this question is harder to address than one may expect. The standard presupposition test of embedding under negation cannot be used to test the projection abilities of the culmination inference. The reason for this is that the negated asserted content of sentences with PFV_H or IPF_R entail the negation of the inferred content: if it is denied that there is a (maximal) part of some possible event, it is *a fortiori* also denied that that possible event is instantiated. Indeed, that negation of IPF_R and PFV_H forms leads to the denial of the entire event is used as an argument by Altshuler (2014) and Singh (1998) respectively for their proposed semantic analyses.

There are other presupposition tests involving embedding under other *presupposition holes* like modals or antecedents of conditionals (cf. Potts 2015). In such cases presuppositions of embedded sentences are

retained. However, there have been arguments that there is a wide range of implicative content that shows projective behavior (Tonhauser et al. 2013). Moreover, the projection potential of conversational implicatures is complicated, and very much under debate (Roberts et al. 2009). Still, let us consider the following example from Russian:

- (18) *Možet byt' Ivan čital poslednie stročki pis'ma.*
 May be Ivan read.IPF.PST last lines letter
 'Ivan may have read the last lines of the letter.'

In (18), one infers that Ivan read the last lines of the letter fully in some possible world. That is, the culmination inference survives *in* embedded contexts like embedded implicatures (Chierchia et al. 2012), and it does not project in the way presuppositions do: no actual culminating reading is implied. But this is expected, given that, unlike presuppositions we know of, the implied culmination entails the asserted content, as noted above. So, the actual occurrence of a culmination cannot be implied, as this is at odds with the explicitly merely possible occurrence of the culmination. Thus, according to this test, the culmination inference from IPF_R behaves more like a conversational implicature and not like a presupposition.

It has also been suggested that while presuppositions (as well as conventional implicatures) are not at-issue content, at least some (though not all) conversational implicatures are at-issue and subject to direct affirmation or denial (Roberts et al. 2009). But judgements about direct denials are heavily influenced by contextual factors, and given the nebulousness of the concept of at-issueness in general (cf., e.g., Tonhauser 2012), the at-issueness status of an implicative content is not easy to determine. Moreover, even if the culmination inference turns out to be not at-issue, it still may be possible that it is either a presupposition, a conversational implicature, or some other kind of implied content.

Finally, reinforcement (Sadock 1978; Hirschberg 1985) is a well-known test of conversational implicatures: unlike entailments or presuppositions, conversational implicatures can be reinforced, i.e., asserted explicitly in subsequent discourse. In this respect, the data below suggests that the culmination inference arising with IPF_R behaves like an implicature:

- (19) *Ja čital poslednie stročki pis'ma. Čital ix do konca.*
 I read.IPF.PST last lines letter read.IPF.PST them until end.
 'I read the last lines of the letter. I read them fully.'

However, as a reviewer points out, reinforcement of the culmination inference of the Russian imperfective is not invariably possible. Take the following example supplied by the reviewer:

- (20) *Ty čital 'Vojnu i mir'? #Čital do konca?*
 you read.IPF.PST 'War and peace' read.IPF.PST until end
 'Have you read 'War and peace'? #Have you read it completely?'

This, in fact, supports our suggestion that the status of the culmination inference (of at least the Russian imperfective) as an implicature might possibly be in need of reevaluation: at the very least it seems to show mixed behavior.

Also, the unavailability presupposition-reinforcement is subject to exceptions at least with the adversative *but* (Horn 1991), and reinforcement without *but* seems at least marginally possible in the case of the process presupposition of RB-achievements,³³ which seems to be in line with the idea that reforcability "applies hand-in-hand with cancelability" (Horn 1991: 317) if this process presupposition is cancellable (Gyarmathy 2015b):

- (21) a. ?I won the race! I participated and won!
 (*win* presupposes *participate*, Abusch 2010)
 b. ?I found my pen! I was looking for it, and I found it!
 (*find* presupposes *look for*, Malink 2008)

³³ Compare (21) with *#Only John smokes! John smokes (and only John)!*

A final, potentially relevant point comes from child language acquisition research. Martin et al. (2018) argue against implicature-based accounts of result inferences of English implied-result verbs like *wash* on the basis that children compute more result inferences in these cases, while they have been shown to compute less (scalar) implicatures than adults (cf. Chierchia et al. 2001, among others). Verbuk and Shultz (2010) showed experimentally that young children also compute less relevance implicatures than adults; in addition, they conclude that “children’s performance on computing implicatures is not a function of broad implicature classes, such as Relevance implicatures vs. scalar implicatures”, but is rather “a function of specific challenges presented by individual small subclasses of implicatures” (2310–2311). Since children have also been shown to overgenerate culminating interpretations of sentences with the Russian imperfective (at least in absence of a *while*-clause that provides an explicit reference time, Kazanina and Phillips 2007), the experimental research on the acquisition of conversational implicatures at least raises questions about the analysis of this inference as a conversational implicature.

In sum, the culmination inference of IPF_R does show some conversational implicature-like features and is definitely unlike presuppositions in that its implied content entails its asserted content. However, its status is far from being settled, especially in light of the more varied distinctions that have recently been made among implicative contents. While deriving the culmination inference via abductive reasoning has allowed us to remain neutral with respect to its pragmatic label, future research is necessary to better understand its exact nature.

6 Agent control and defeasible causatives in English

In this section, we would like to take a look at a claim that has been made for a restricted set of verbal predicates in Germanic and Romance languages, which Martin and Schäfer (2012) call *defeasible causatives*: the perfective form of these predicates does not entail the occurrence of an associated change of state in their theme.

Defeasible causatives in languages like French or English are predicates that only entail a corresponding result if their subject is a causer, rather than an agent, as argued by Martin and Schäfer (2012), among others. Let us take the following English examples from Piñón (2014) to illustrate the point:

- (22) a. They **offered** me a position at their bank, but I turned it down. [Agent]
 b. Living in a large city **offered** Rebecca a number of advantages, #but she refused them. [Causer]

As this example shows, defeasible causatives display a different kind of non-culmination reading as PFV_H and IPF_R, because the former, but not the latter, allow for the total lack of a partial change of the relevant kind. This is what Demirdache and Martin (2015) call a *zero change of state* (zero CoS, for short) construal (as opposed to a *partial change of state* construal we have been discussing so far). Demirdache and Martin argue that in most languages, zero CoS readings, as opposed to partial CoS readings, tend to require an agentive external argument.

We propose that, while the basic observation about contrasts involving agents and causers is well-founded, it is, in fact, possible to get a zero CoS reading of a sentence with a causer subject – even though this is much harder to get than in the case of an agentive subject.³⁴ In particular, we hypothesize that the main reason behind the unacceptability of (22b) is the use of the CoS-denial clause with *refuse*, which is semantically odd

³⁴ That *offer*-verbs can have a zero CoS can already been seen from the relevant literature. Martin and Schäfer (2017) note that Hans Kamp, in a recent manuscript, observes that “English *offer* differs from French *offrir* in that the contrast between the agentive vs. non-agentive use seems to be much less prominent. More generally, Kamp suggests that for the English counterparts of [defeasible causatives], the inference that the result takes place seems to be cancellable with causer subjects, too, although it is much stronger than the inference with agentive subjects. Finally, Kamp suggests that this may have to do with the fact that English is much more tolerant than French on the point of using primarily agentive verbs with non-agentive subjects.” Fabienne Martin (p.c.) further notes that Kratzer (2013) has brought examples to this effect (*The breakfast buffet offered us a bowl of porridge*, *Her junk mail folder was cluttered with messages offering her substantial sums of money*); see also discussion by Oehrle (1976: 101) of the sentence: *Access to the tapes offered Cox the best evidence*.

for lack of a conversational partner to make the refusal to. Using a less biased CoS-denying clause makes a zero CoS reading admissible, especially if the clause is present tensed:

(23) Living in a large city **offers** you a number of advantages, you just have to take them. [Causer]

As argued by Piñón (2014), there is an aspectual class difference between agent-subject and causer-subject counterparts of the same defeasible causative predicate: the agent-subject is non-stative (an accomplishment or an activity), while the causer-subject is stative or an achievement (on an inchoative interpretation). In the case of *offer*, therefore, the simple present *cannot* be used in the agentive case, and so cannot be compared with the non-agentive case directly. However, zero CoS readings with causer subjects are possible even in the case of past tense sentences:

(24) Living in a large city **offered** you a number of advantages, you just didn't take them. [Causer]

So it seems that the ease of cancellation of an inference in the case of defeasible causatives in English is i) graded, and ii) is dependent on a number of lexical,³⁵ syntactic and other, contextual, factors. Given that both properties i) and ii) have been observed in the case of partial CoS readings in languages that allow for such construals (cf., e.g., Pederson 2008; Arunachalam and Kothari 2011), it at least suggests the possibility that the defeasible CoS inference of defeasible causatives is also amenable to a similar abductive inference process as the culmination inference from PFV_H and IPF_R. In order to construct such an inference, a suitable semantic analysis of defeasible causatives is needed which supplies the "observation" about which we can reason.

While the semantic analysis of defeasible causatives is still a matter of discussion (cf. Koenig and Davis 2001; Martin 2015; Martin and Schäfer 2017), the recent proposal by Martin (2015) appears a promising proposal to use to this end. Without going into the details, and simplifying Martin's proposal, the key idea behind her proposal is the following. The difference between defeasible causatives with agent and causer subjects is how much the *process* causing the associated change is *indicative* of this change in and of itself – in a special sense of indicativity building on Varasdi's (2014) formalisation of the concept in his analysis of the progressive. Intuitively speaking, the activity that an agent intentionally undertakes in order to achieve some goal (e.g., the teaching activity undertaken by a teacher) is highly indicative of the associated change (e.g., the learners learning the material) as its result. This is especially so if we restrict our attention to a limited set of possible alternative outcomes, much as in the case of focus alternatives. In contrast, such a link between the cause and the eventual result is non-existent or much weaker in the non-agentive case.³⁶

Martin's account is based upon a form of reasoning that is quite similar to our abduction-based analysis of implied success. Recall that abduction often involves reasoning about an antecedent of a conditional based on its consequent: in other words, a necessary condition for the antecedent is treated as grounds for assuming that the antecedent holds. Varasdi's (2014) account of the progressive, which Martin (2015) builds on, also proposes that we reason from necessary conditions to antecedents. In particular, on his account, we are to seek an explanation of facts of the present (the events we observe) in terms of types of events whose necessary conditions are best saturated by events in the present.³⁷

Very roughly, then, the following kind of abductive argument could be constructed for defeasible causatives,

³⁵ E.g., a zero CoS reading seems virtually impossible for *teach* with a causer subject, as in (3b), repeated below as (i):

(i) Lipson's textbook taught me Russian, #but I did not learn anything. (Martin and Schäfer 2017)

³⁶ This is arguably illustrated by the fact that the causing event is much more difficult to characterize out of the blue for non-agentive cases based solely on the defeasible causative. Take *Ivan taught me to be careful*, which has an agentive reading (with the implication of me now being careful being cancellable), and a non-agentive one (where the result is entailed, not simply implied). We can say with certainty that in the agentive case, Ivan engaged in some coaching activity with me. However, on the non-agentive reading, the kind of event involving Ivan that led to me becoming careful is underspecified.

³⁷ E.g., if Károly's completely crossing the street necessarily requires Károly moving beforehand on the street in a direction from one side to the other, then if we observe Károly in this motion, we may be justified in saying *Károly is crossing the street* under certain circumstances (for details, see Varasdi 2014).

where P is true of the causing event, and Q is true of the sum of the causing event and the change of state associated with the defeasible causative:

1. Observation: there is a process of kind P (e.g., a teacher talking about a topic).
2. Theory: If there is an event of kind Q (e.g., learners learning about the topic via being taught), then there is a process of kind P (i.e., P is a necessary condition for Q).
3. Explanation (abduced): there is an event of kind Q .

Because agentive processes in the case of defeasible causatives are very much *indicative* of the corresponding CoS (based on Martin 2015), there cannot be many other Q 's that have P as their necessary conditions. The opposite holds for non-agentive cases: e.g., there being a book including text on some topic (a P -event) is an important necessary component of not just explaining that topic to its readers, but of many other events: e.g., it also features in the reading and in the writing of that text. So while a *single* Q features in the relevant rule from our theory for causatives with *agent* subjects (or it is at least very much highlighted via indicativity and is thus involved in the *best* explanation), *several* Q 's feature for causatives with *causer* subjects, none of which appears to be better as an explanation for the observed process than the other.

Since we can abduce the caused change from an agentive process, but not typically from a non-agentive process, we can now adopt Martin's (2015) argumentation that causer (but not agent) subject defeasible causatives must *semantically* include the caused change as their component, because it would not be inferred otherwise (and would only have a process component, but they would not be causatives). Thus, occurrence of the change caused by the process part in the case of agentive defeasible causatives is abduced, and is thus cancellable. However, it is entailed by their causer subject counterparts, and is thus typically not cancellable (unless the process is indicative of the change).

While this is a very rough proposal for defeasible causatives, we hope it motivates further research that aims to provide a uniform explanation of why very different kinds of constructions allowing for (but not requiring) non-successful readings all tend to *implicate* success.

7 Conclusion

The focus of this paper was defeasible inferences of successful culmination, and in particular, the culmination inferences found with the Hindi (simple verb) perfective and the Russian imperfective. We also briefly considered result inferences found with English defeasible causatives. We proposed that while these different constructions have different semantics, the inference to success that they share has the *same* explanation: it is abduced based on their asserted content (i.e., their truth-conditional semantics) and knowledge that includes information from diverse domains, such as semantics, pragmatics and world knowledge, among others.

We have aimed to show how the inferences under scrutiny can be uniformly analyzed in a single framework for defeasible reasoning, namely, abduction. While abduction is known to be a rather unconstrained tool, we have attempted to show how it can nevertheless be used to make (correct) predictions. An advantage of approaching the relevant culmination inferences through abduction is that we can embed this piece of reasoning in a more general reasoning framework that has been argued to be cognitively relevant and computationally viable. In addition, while, as we have shown, the abductive account is able to incorporate the relevance of competing alternative forms, it does not rely on competition to derive the relevant inferences, and as a consequence has no problems in the face of cases where the inference goes through despite the availability of a competing form expressing the same meaning.

That said, we do not aim to completely reject previous accounts of culmination inferences, and we have given no reason to supplant (Neo-)Gricean pragmatics.³⁸ Instead, as we have attempted to show that it is

³⁸ See Lepore and Stone (2015) for a recent attempt. In particular, they reject the category of *implicatures* and claim that all pragmatically enhanced content is a question of unruly imagination. See Borg (forthcoming) for further discussion.

entirely possible to incorporate these approaches (or selected elements thereof) in the framework of abduction and build on the observations in the previous literature. What abduction offers us is a way to isolate and formalize how various factors – the asserted content, very general non-defeasible rules, competing forms, etc. – contribute to the defeasible inferences we draw from various sentences in a given context.

Acknowledgment: We are grateful to Károly Varasdi and Fabienne Martin for their constructive and valuable input, as well as to the participants at the TELIC 2017 Workshop on Nonculminating, Irresultative and Atelic Readings of Telic Predicates at the University of Stuttgart and the anonymous reviewers from Linguistics and this special issue for their helpful feedback.

References

- Abusch, Dorit. 2010. Presupposition triggering from alternatives. *Journal of Semantics* 27(1). 37–80.
- Altshuler, Daniel. 2013. There is no neutral aspect. In Todd Snider (ed.), *Proceedings of Semantics and Linguistic Theory (SALT)* 23, 40–62. Washington, DC: LSA Publications.
- Altshuler, Daniel. 2014. A typology of partitive aspectual operators. *Natural Language & Linguistic Theory* 32(3). 735–775.
- Altshuler, Daniel. 2016. *Events, states and times. An essay on narrative discourse in English*. Warsaw & Berlin: De Gruyter Open.
- Altshuler, Daniel & Károly Varasdi. 2015. A proof of definitional adequacy of RESULT and NARRATION. In Sarah D'Antonio, Mary Moroney & Carol Rose Little (eds.), *Proceedings of Semantics and Linguistic Theory (SALT)* 25, 38–56. Washington, DC: LSA Publications.
- Arche, María J. 2014. The construction of viewpoint aspect: the imperfective revisited. *Natural Language & Linguistic Theory* 32(3). 791–831.
- Arunachalam, Sudha & Anubha Kothari. 2010. Telicity and event culmination in Hindi perfectives. In Pier Marco Bertinetto, Anna Korhonen, Alessandro Lenci, Alissa Melinger, Sabine Schulte im Walde & Aline Villavicencio (eds.), *Proceedings of verb 2010, interdisciplinary workshop on verbs: The identification and representation of verb features*, 16–19. Pisa: Scuola Normale Superiore & Università di Pisa. <http://www.ims.uni-stuttgart.de/institut/mitarbeiter/schulte/publications/proceedings/verbs-10.pdf>.
- Arunachalam, Sudha & Anubha Kothari. 2011. An experimental study of Hindi and English perfective interpretation. *Journal of South Asian Linguistics* 4(1). 27–42.
- Asher, Nicholas. 1992. A default, truth conditional semantics for the progressive. *Linguistics and Philosophy* 15(5). 469–508.
- Bar-El, Leora, Henry Davis & Lisa Matthewson. 2005. On non-culminating accomplishments. In Leah Bateman & Cheron Ussery (eds.), *Proceedings of the 35th annual meeting of the North East Linguistics Society (NELS)*, 87–102. Amherst, MA: GLSA Publications.
- Bohnemeyer, Jürgen & Mary Swift. 2004. Event realization and default aspect. *Linguistics and Philosophy* 27(3). 263–296.
- Bonawitz, Elizabeth Baraff & Tania Lombrozo. 2012. Occam's rattle: Children's use of simplicity and probability to constrain inference. *Developmental Psychology* 48(4). 1156–1164.
- Borg, Emma. forthcoming. Implicatures. In Daniel Altshuler (ed.), *Linguistics meets Philosophy*, Cambridge: Cambridge University Press.
- Chierchia, Gennaro, Stephen Crain, Maria Teresa Guasti, Andrea Gualmini & Luisa Meroni. 2001. The acquisition of disjunction: Evidence for a grammatical view of scalar implicatures. In Anna H.-J. Do, Laura Domínguez & Aimee Johansen (eds.), *Proceedings of the 25th Boston University conference on language development*, 157–168. Somerville, MA: Cascadia Press.
- Chierchia, Gennaro, Danny Fox & Benjamin Spector. 2012. The grammatical view of scalar implicatures and the relationship between semantics and pragmatics. In Claudia Maienborn, Klaus von Stechow & Paul Portner (eds.), *Semantics: An international handbook of natural language meaning*, vol. 3, 2297–2332. Berlin & Boston: De Gruyter Mouton.
- Clark, Keith L. 1978. Negation as failure. In Hervé Gallaire & Jack Minker (eds.), *Logic and data bases*, 293–322. New York: Springer.
- Comrie, Bernard. 1976. *Aspect*. Cambridge: Cambridge University Press.
- Dahl, Eystein. 2010. *Time, tense and aspect in early vedic grammar: Exploring inflectional semantics in the rigveda*. Leiden: Brill Academic Publishers.
- Dascal, Marcelo. 1977. Conversational relevance. *Journal of Pragmatics* 1(4). 309–327.
- Demirdache, Hamida & Fabienne Martin. 2015. Agent control over non culminating events. In Elisa Barrajón López, José Luis Cifuentes Honrubia & Susana Rodríguez Rosique (eds.), *Verb classes and aspect*, 185–217. Amsterdam & Philadelphia: John Benjamins.
- Douven, Igor. 2011. Abduction. In Edward N. Zalta (ed.), *The Stanford encyclopedia of philosophy*, Spring 2011 edn. <http://plato.stanford.edu/archives/spr2011/entries/abduction/>.

- Dowty, David R. 1979. *Word meaning and Montague grammar*. Dordrecht: D. Reidel.
- Filip, Hana. 1999. *Aspect, eventuality types, and nominal reference*. New York: Routledge.
- Filip, Hana. 2000. The quantization puzzle. In Carol Tenny & James Pustejovsky (eds.), *Events as grammatical objects, from the combined perspectives of lexical semantics, logical semantics and syntax*, 39–91. Stanford, CA: CSLI Publications.
- Filip, Hana. 2003. Prefixes and the delimitation of events. *Journal of Slavic Linguistics* 11(1). 55–101.
- Filip, Hana. 2008. Events and maximalization: The case of telicity and perfectivity. In Susan D. Rothstein (ed.), *Theoretical and crosslinguistic approaches to the semantics of aspect*, 217–256. Amsterdam & Philadelphia: John Benjamins.
- Forsyth, James. 1970. *A grammar of aspect: Usage and meaning in the Russian verb*. Cambridge: Cambridge University Press.
- Glovinskaja, Marina Jakovlevna. 1982. *Semantičeskije tipy vidovych protivopostavlenij russkogo glagola* [Semantic types of russian verbal aspect opposition]. Moscow: Nauka.
- Glovinskaja, Marina Jakovlevna. 1989. Semantika, pragmatika i stilistika vido-vremennyx form [Semantics, pragmatics and stylistics of aspect-tense forms]. In Dmitrij N. Šmelev (ed.), *Grammatičeskije issledovanija: Funkcional'no-stilističeskij aspekt*, [Grammatical Research: Functional-stylistic Aspect], 74–143. Moscow: Nauka.
- Grøn, Atle. 2003. *The semantics and pragmatics of the Russian factual imperfective*. Oslo: University of Oslo dissertation.
- Grøn, Atle. 2007. Horn strategies and optimization in Russian aspect. In Anton Benz, Christian Ebert & Rob van Rooij (eds.), *Proceedings of the ESSLLI workshop on Language, games, and evolution*, <https://homepage.univie.ac.at/josef.hofbauer/07hutt.pdf>.
- Grøn, Atle. 2008. Russian aspect as bidirectional optimization. In Franc Marusic (ed.), *Studies in formal Slavic linguistics*, 121–137. Bern: Peter Lang.
- Gyarmathy, Zsófia. 2015a. *Achievements, durativity and scales*. Berlin: Logos Verlag.
- Gyarmathy, Zsófia. 2015b. Culminations and presuppositions. In Thomas Brochhagen, Floris Roelofsen & Nadine Theiler (eds.), *Proceedings of the 20th Amsterdam Colloquium*, 167–176. Amsterdam: ILLC, Department of Philosophy, University of Amsterdam.
- Hirschberg, Julia. 1985. *A theory of scalar implicature*. Philadelphia, PA: University of Pennsylvania dissertation.
- Hobbs, Jerry R. 2004. Abduction in natural language understanding. In Laurence R. Horn & Gregory Ward (eds.), *Handbook of pragmatics*, 724–741. Oxford: Blackwell.
- Hobbs, Jerry R., Mark E. Stickel, Douglas E. Appelt & Paul Martin. 1993. Interpretation as abduction. *Artificial Intelligence* 63(1-2). 69–142.
- Horn, Laurence R. 1991. Given as new: When redundant affirmation isn't. *Journal of Pragmatics* 15(4). 313–336.
- Hulanicki, Leo. 1973. The actional perfect in Russian. *Slavic and East European Journal* 17(2). 174–183.
- Josephson, John R. & Susan G. Josephson. 1996. *Abductive inference: Computation, philosophy, technology*. Cambridge: Cambridge University Press.
- Kagan, Olga. 2016. *Scalarity in the verbal domain: The case of verbal prefixation in Russian*. Cambridge: Cambridge University Press.
- Kazanina, Nina & Colin Phillips. 2007. A developmental perspective on the imperfective paradox. *Cognition* 105(1). 65–102.
- Koenig, Jean-Pierre & Anthony R. Davis. 2001. Sublexical modality and the structure of lexical semantic representations. *Linguistics and Philosophy* 24(1). 71–124.
- Koenig, Jean-Pierre & Nuttannart Muansuwan. 2000. How to end without ever finishing: Thai semi-perfectivity. *Journal of Semantics* 17(2). 147–182.
- Kratzer, Angelika. 2013. Creating a family: Constructing transfer of possession verbs. Paper presented at the *Little v workshop*, Leiden.
- Krifka, Manfred. 1989. Nominal reference, temporal constitution and quantification in event semantics. In Renate Bartsch, Johan van Benthem & Peter von Emde Boas (eds.), *Semantics and contextual expression*, 75–115. Dordrecht: Foris.
- Krifka, Manfred. 1992. Thematic relations as links between nominal reference and temporal constitution. In Ivan A. Sag & Anna Szabolcsi (eds.), *Lexical matters*, 29–53. Stanford, CA: CSLI Publications.
- Landman, Fred. 1992. The progressive. *Natural Language Semantics* 1. 1–32.
- Lepore, Ernie & Matthew Stone. 2015. *Imagination and convention: Distinguishing grammar and inference in language*. Oxford: Oxford University Press.
- Levinson, Stephen C. 2000. *Presumptive meanings: The theory of generalized conversational implicature*. Cambridge, MA: MIT Press.
- Malink, Markoa. 2008. Right boundary achievements under conative negation. In Anita Steube (ed.), *The discourse potential of underspecified structures* (Language, Context and Cognition 8), 145–162. Berlin & New York: De Gruyter.
- Martin, Fabienne. 2015. Explaining the link between agentivity and non-culminating causation. In Sarah D'Antonio, Mary Moroney & Carol Rose Little (eds.), *Proceedings of Semantics and Linguistic Theory (SALT) 25*, 246–266. Washington, DC: LSA Publications.
- Martin, Fabienne, Hamida Demirdache, Isabel García del Real, Angeliek van Hout & Nina Kazanina. 2018. Children's non-adultlike interpretations of telic predicates across languages. Unpublished manuscript.
- Martin, Fabienne & Zsófia Gyarmathy. 2017. A finer-grained typology of perfective operators. Paper presented at the *Conference of Syntax and Semantics in Paris (CSSP 2017)*.
- Martin, Fabienne & Florian Schäfer. 2012. The modality of 'offer' and other defeasible causative verbs. In Nathan

- Arnett & Ryan Bennett (eds.), *Proceedings of West Coast Conference on Formal Linguistics (WCCFL)* 30, 248–258. Somerville, MA: Cascadilla Press.
- Martin, Fabienne & Florian Schäfer. 2017. Sublexical modality in defeasible causative verbs. In Ana Arregui, María Luisa Rivero & Andrés Salanova (eds.), *Modality across syntactic categories*, chap. 6, 87–108. Oxford: Oxford University Press.
- McIlraith, Sheila A. 1998. Logic-based abductive inference. Tech. Rep. KSL-98-19. <http://ksl-web.stanford.edu/people/sam/abduction.ps>.
- Oehrle, Richard Thomas. 1976. *The grammatical status of the English dative alternation*. Cambridge, MA: Massachusetts Institute of Technology dissertation.
- Paducheva, Elena V. 1995. Taxonomic categories and semantics of aspectual opposition. In Pier Marco Bertinetto, Valentina Bianchi, James Higginbotham & Mario Squartini (eds.), *Temporal reference, aspect and actionality: Semantic and syntactic perspectives*, 71–89. Turin: Rosenberg and Sellier.
- Pancheva, Roumyana. 2003. The aspectual makeup of perfect participles and the interpretations of the perfect. In Artemis Alexiadou, Monika Rathert & Arnim von Stechow (eds.), *Perfect explorations*, 277–306. Berlin & New York: Mouton de Gruyter.
- Parsons, Terence. 1990. *Events in the semantics of English*. Cambridge, MA: MIT Press.
- Pederson, Eric. 2008. Event realization in Tamil. In Melissa Bowerman & Penelope Brown (eds.), *Crosslinguistic perspectives on argument structure: Implications for learnability*, 331–355. Mahwah, NJ: Lawrence Erlbaum.
- Piñón, Christopher. 1997. Achievements in an event semantics. In Aaron Lawson (ed.), *Proceedings of Semantics and Linguistic Theory (SALT)* 7, 273–296. Washington, DC: LSA Publications.
- Piñón, Christopher. 2009. Another look at the actuality entailment of certain modal verbs, Paper presented at *Genericity: Interpretation and Uses*, Paris.
- Piñón, Christopher. 2011. The pragmatics of actuality entailments, Paper presented at *Aspect and Modality in Lexical Semantics*, Stuttgart.
- Piñón, Christopher. 2014. Reconsidering defeasible causative verbs, Paper presented at the *11th International Conference on Actionality, Tense, Aspect, Modality/Evidentiality (Chronos 11)*, Pisa, 16–18 June.
- Potts, Christopher. 2015. Presupposition and implicature. In Shalom Lappin & Chris Fox (eds.), *The handbook of contemporary semantic theory*, 2nd edn. Hoboken, NJ: Wiley-Blackwell.
- Prior, Arthur N. & Kit Fine. 1977. *Worlds, times and selves*. Amherst, MA: University of Massachusetts Press.
- Roberts, Craige, Mandy Simons, David Beaver & Judith Tonhauser. 2009. Presupposition, conventional implicature, and beyond: A unified account of projection. In Nathan Klinedinst & Daniel Rothschild (eds.), *Proceedings of the ESSLLI workshop on new directions in the theory of presupposition*, Toulouse: ESSLLI.
- Sadock, Jerrold M. 1978. On testing for conversational implicature. In Peter Cole (ed.), *Syntax and semantics: Pragmatics*, 281–297. Cambridge, MA: Academic Press.
- Singh, Mona. 1991. The perfective paradox: Or how to eat your cake and have it too. In Laurel Sutton, Christopher Johnson & Ruth Shields (eds.), *Proceedings of the seventeenth annual meeting of the Berkeley Linguistics Society*, 469–479. Berkeley, CA: Berkeley Linguistics Society.
- Singh, Mona. 1998. On the semantics of the perfective aspect. *Natural Language Semantics* 6(2). 171–199.
- Smith, Carlota S. 1991. *The parameter of aspect*. Dordrecht: Kluwer Academic Press.
- Tatevosov, Sergei. 2008. Subevental structure and non-culmination. In Olivier Bonami & Patricia Cabredo Hofherr (eds.), *Empirical issues in syntax and semantics* 7, 393–422. Paris: CNRS Éditions.
- Tonhauser, Judith. 2012. Diagnosing (not-)at-issue content. In Elizabeth Bogal-Allbritten (ed.), *Proceedings of Semantics of Under-represented Languages of the Americas (SULA)* 6, 239–254. Amherst, MA: GLSA Publications.
- Tonhauser, Judith, David Beaver, Craige Roberts & Mandy Simons. 2013. Toward a taxonomy of projective content. *Language* 89(1). 66–109.
- Varasdi, Károly. 2010. A higher order extensional framework for the progressive. *Journal of Semantics* 27(2). 177–206.
- Varasdi, Károly. 2014. Making progressives: Necessary conditions are sufficient. *Journal of Semantics* 31(2). 179–207.
- Vendler, Zeno. 1957. Verbs and times. *The Philosophical Review* 66(2). 143–160.
- Verbuk, Anna & Thomas Shultz. 2010. Acquisition of relevance implicatures: A case against a rationality-based account of conversational implicatures. *Journal of Pragmatics* 42(8). 2297–2313.
- Zinova, Julia. 2017. *Russian verbal prefixation: A frame semantic analysis*. Düsseldorf: Heinrich-Heine-Universität dissertation.
- Zucchi, Sandro. 1999. Incomplete events, intensionality and imperfective aspect. *Natural Language Semantics* 7(2). 179–215.