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A problem of aspectual composition in Polish

1. The problem

A striking fact about Polish (and comparable Slavic languages) is that a syntactically bare plural or bare singular mass noun phrase occurring as an argument of a perfective verb cannot receive a bare plural or bare singular mass interpretation.[1] This restriction holds independently of which argument position the bare noun phrase fills. Moreover, as the following contrasts demonstrate, the restriction does not apply to a bare noun phrase in combination with an imperfective verb:

(1) a. Basia czytała^i artykuły.
         Basia read   articles-ACC
         'Basia read articles.'
     b. #Basia prze·czytała^p artykuły.
         Basia *prze*-read   articles-ACC
         (Unacceptable on bare plural interpretation of object)

(2) a. Studenci czytali^i ten artykuł.
         students read   this article-ACC
         'Students read this article.'
     b. #Studenci prze·czytali^p ten artykuł.
         students *prze*-read   this article-ACC
         (Unacceptable on bare plural interpretation of subject)

(3) a. Irenka u·dowadniała^i twierdzenia.
         Irenka *u*-proved   theorems-ACC
         'Irenka proved theorems.'
     b. #Irenka u·dowodniła^p twierdzenia.
         Irenka *u*-proved   theorems-ACC
         (Unacceptable on bare plural interpretation of object)

(4) a. Studenci u·dowadniali^i to   twierdzenie.
         students *u*-proved   this theorem-ACC
         'Students proved this theorem.'
     b. #Studenci u·dowodnili^p to   twierdzenie.
         students *u*-proved   this theorem-ACC
         (Unacceptable on bare plural interpretation of subject)

(5) a. Tomasz piekł^i chleb.
         Tomasz baked bread-ACC
         'Tomasz baked bread.'
     b. #Tomasz u·piekł^p chleb.
         Tomasz *u*-baked bread-ACC
         (Unacceptable on bare singular mass interpretation of object)

(6) a. Mleko kwaśniało^i w lodówce.
         milk   turned-sour in refrigerator-LOC
         'Milk turned sour in the refrigerator.'

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[1] In this paper I make use of the following abbreviations: (superscript) `i` = imperfective | (superscript) `p` = perfective | ACC = accusative | GEN = genitive | LOC = locative. In addition, I employ a dot (·) to mark the boundary between a perfective prefix and the verb stem, even if the verb itself is imperfective (i.e., is derived via secondary imperfectivization from a perfective verb).

b. #Mleko s·kwaśniało^P w lodówce.
   milk   *s*-turned-sour in refrigerator-LOC
   (Unacceptable on bare singular mass interpretation of subject)

Since Polish lacks overt articles, a syntactically bare plural noun phrase may in principle be interpreted as either a plural definite or a bare plural. Similarly, a syntactically bare singular mass noun phrase allows for either a singular definite or a bare singular interpretation. It is only the bare plural or bare singular interpretation that is excluded in the (b)-sentences of (1)–(6). The (b)-sentences are acceptable if the bare noun phrase is understood to be definite.

The aforementioned restriction does not extend to singular *count* noun phrases, i.e., there is no prohibition against a syntactically bare singular count noun phrase in combination with a perfective verb from being interpreted as a singular indefinite. Although it is true that—in the absence of contextual information to the contrary—a bare singular count noun phrase in combination with a perfective verb is preferably interpreted as definite, this preference can be overridden with a judicious choice of adjectival modifier (or an appropriate context):

(7) a. Basia prze·czytała^P inny   artykuł.
        Basia *prze*-read   other-ACC article-ACC
        'Basia read another (i.e., a different) article.'
     b. Irenka u·dowodniła^P podobne   twierdzenie.
        Irenka *u*-proved   similar-ACC theorem-ACC
        'Irenka proved a similar theorem.'

Thus, the restriction in question crosscuts the distinction between definites and indefinites, the crucial factor being whether or not the syntactically bare noun phrase is interpreted as though it were a bare (i.e., 'articleless') noun phrase.

Contrasts such as those in (1)–(6) may seem a bit subtle to base a problem on—after all, the (b)-sentences do have an acceptable interpretation. If this is a concern, let's consider another equally puzzling fact about Polish, namely, that durative adverbials are incompatible with perfective verbs. A durative adverbial is a temporal phrase like *cały dzień* '(the) whole day' or *dwie godziny* '(for) two hours'—intuitively, it says something about how long a situation lasts. The result of adding a durative adverbial to (1)–(6) is shown in the next set of examples:

(8) a. Basia cały   dzień czytała^i artykuły.
        Basia whole day   read   articles-ACC
        'Basia read articles the whole day.'
     b. *Basia cały   dzień prze·czytała^P artykuły.
        Basia whole day   *prze*-read   articles-ACC

(9) a. Przez   lata studenci czytali^i ten artykuł.
        through years students read   this article-ACC
        'For years students read this article.'
     b. *Przez   lata studenci prze·czytali^P ten artykuł.
        through years students *prze*-read   this article-ACC

(10) a. Irenka dwie godziny   u·dowadniała^i twierdzenia.
        Irenka two hours-ACC *u*-proved   theorems-ACC
        'Irenka proved theorems for two hours.'
     b. *Irenka dwie godziny   u·dowodniła^P twierdzenia.
        Irenka two hours-ACC *u*-proved   theorems-ACC

(11) a. Przez   tydzień   studenci u·dowadniali^i to twierdzenie.
        through week-ACC students *u*-proved   this theorem-ACC
        'For a week students proved this theorem.'

    b. *Przez   tydzień   studenci u·dowodnili[P] to   twierdzenie.
       through week-ACC students *u*-proved   this theorem-ACC

(12) a. Tomasz całe   przedpołudnie piekł[i] chleb.
       Tomasz whole morning-ACC baked bread-ACC
       'Tomasz baked bread the whole morning.'
    b. *Tomasz całe   przedpołudnie u·piekł[P] chleb.
       Tomasz whole morning-ACC *u*-baked bread-ACC

(13) a. Przez   viele dni   mleko kwaśniało[i] w lodówce.
       through many days-GEN milk   turned-sour in refrigerator-LOC
       'For many days milk turned sour in the refrigerator.'
    b. *Przez   viele dni   mleko s·kwaśniało[P] w lodówce.
       through many days-GEN milk   *s*-turned-sour in refrigerator-LOC

The (b)-sentences in (8)–(13), in contrast to those in (1)–(6), lack an acceptable interpretation altogether.

    Summarizing, we have two observations about Polish, which I recast as the following generalizations:

(i) If a verb is perfective, then it cannot have a syntactically bare plural or singular mass noun phrase argument that receives a bare plural or bare singular mass interpretation.[2]

(ii) If a verb is perfective, then it (or the verb phrase that it heads) cannot be modified by a durative adverbial.

As a null hypothesis it is reasonable to conjecture that the same property of perfective verbs is responsible for both of these generalizations. What connects (i) and (ii) is that a noun phrase that receives a bare interpretation can always appear within the scope of a durative adverbial. Given this connection, since perfective verbs resist modification by a durative adverbial (according to (ii)), it follows that they also should not countenance noun phrases that receive a bare interpretation as their arguments (according to (i)), for if contrary to (i) they did allow noun phrases that receive a bare interpretation as their arguments, then they should also accept modification by a durative adverbial, which would contradict (ii). In other words, the generalizations in (i) and (ii) are arguably just two sides of the same coin.

    In this paper I will focus on the generalization expressed in (i). Even so, any account of (i) should automatically shed light on the factor responsible for (ii), given that—as just argued—(i) and (ii) are not independent generalizations. I speak of 'a problem of aspectual composition' in the title because any analysis of (i) crucially has to address how perfective and imperfective verbs semantically combine with their noun phrase arguments. In particular, it does not suffice to speak in metaphors about perfectivity and to imagine the problem thereby solved.

    The remainder of this paper consists of two main parts. In the first (section 2) I discuss three strategies for solving this aspectual problem that I regard as unsuccessful. In the second part (section 3) I present a new analysis of the problem, one that avoids the various weaknesses of the first three strategies.

2. Three strategies

Although I am not aware of detailed analyses of the aspectual problem in question, I can think of three main strategies that might be pursued (and, to some extent, have been pursued) for its solution and that I judge as unsuccessful. In this section I will briefly describe each of these strategies and clarify why it is problematic.

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[2] Henceforth I will often speak of a 'bare interpretation' for short.

2.1. Strategy 1: looking to syntax

The first strategy (strategy 1) is unabashedly syntactic and is intended as a straw man, though in light of the recent trend of syntactic approaches to aspect, I feel compelled to address it.

As just stated, strategy 1 is to syntacticize the problem. Minimally, such a strategy might look something like this. Assume that perfective verbs bear a feature [+pf] and that noun phrases having a determiner bear a feature [+det]. We could then say that [+pf] verbs subcategorize for [+det] noun phrases. In order for this to work as intended, syntactically bare noun phrases that are interpreted as though an article were present should be specified as [+det]. Furthermore, assuming that a verb projects its [+pf] feature to the verb phrase that it heads, we could say that durative adverbials subcategorize for [−pf] verb phrases, where the feature [−pf] is used to characterize imperfective verbs and the verb phrases that they head.

This strategy may sound neat at first, especially since a good case can be made in Polish and other Slavic languages for a syntactic feature [±pf]. However, a moment's reflection suggests that without semantic support such a purely formal solution offers no insight into why the data pattern as they do. Why should [+pf] verbs subcategorize for [+det] noun phrases, as opposed to subcategorizing for [−det] noun phrases or to simply leaving this feature unspecified? And why should durative adverbials select for [−pf] (and not [+pf]) verb phrases to modify? Any substantive answers to these questions will make reference to the presumed semantic content of the features. And yet if so, then any syntactic analysis of this phenomenon needs to be backed up by a semantic one.

Note that I do not claim that features such as [±pf] or [±det] do not exist or do not play a role in Polish (I leave this open). Indeed, it may even be the case that a syntactic analysis using such features lives alongside a semantic one. I merely emphasize that no insight is won into the problem unless such features have semantic content, and so therefore the task should be to elucidate this content.

I can imagine more subtle variations on this strategy that rely on functional projections such as an aspect phrase and that attempt to reduce the phenomenon to (putatively) independently motivated principles of 'feature-checking' or the like. However, whatever other virtues that a more elaborate syntactic analysis may offer, it would not be semantic as long as it is solely syntactic, and so my point would still stand.

2.2. Strategy 2: finding a type conflict

The second strategy (strategy 2) looks to type theory for a solution to the problem. Specifically, it claims that the reason why a perfective verb cannot combine with a noun phrase that receives a bare interpretation is that the logical type of the verb and the logical type of the noun phrase *conflict*.

Strategy 2 might be elaborated as follows. Assume that bare plural and bare singular mass noun phrases are obligatorily analyzed as one-place predicates. Suppose, moreover, that imperfective verbs may (optionally) be analyzed as 'incorporating', i.e., as applying to a predicate argument and as existentially quantifying over their internal argument, whereas perfective verbs may only be analyzed as applying to individual arguments. Given this setup and the further assumption that no type-shifting is allowed to rectify the situation, we would predict that only imperfective verbs can combine with noun phrases that receive a bare interpretation.[3]

More concretely, and with an eye to the contrast in (1), suppose that the bare plural interpretation of *artykuły* 'articles' must be analyzed as in (14a), that *czytać*[i] 'read' may optionally be analyzed as an 'object-incorporating' verb as in (14b), and that *prze·czytać*[p] 'read' must be analyzed as in (14c). (For the sake of argument, imagine that we know how *Read*[i] and *Read*[p]

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[3] I thought of this strategy in connection with an analysis of incorporation proposed in van Geenhoven (1998), but I emphasize that strategy 2 as described is due to me—van Geenhoven says nothing about the analysis of Slavic (let alone Polish) and therefore is not responsible for what I say here.

are to be related—the present point does not depend on the details of this.) It would then follow that *czytać*[i] could, but *prze·czytać*[P] could not, combine with *artykuły*.

(14)   a.   artykuły 'articles' $\rightsquigarrow \lambda x[Articles(x)]$
       b.   czytać[i] 'read' $\rightsquigarrow \lambda P \lambda x[\exists y[Read^i(x,y) \wedge P(y)]]$
       c.   prze·czytać[P] 'read' $\rightsquigarrow \lambda y \lambda x[Read^p(x,y)]$

Like strategy 1, strategy 2 is enticing at first, precisely because it is so simple. Yet the price of its simplicity is its precariousness, for if it turned out (for any reason) that *artykuły* could optionally be analyzed as a quantifier,[4] then it could easily combine with *prze·czytać*[P], and all bets would be off. Alternatively, if *prze·czytać*[P] could optionally be analyzed as 'incorporating', the analysis would similarly fall apart. But even if we could (somehow) independently guarantee that *prze·czytać*[P] and *artykuły* cannot combine because of a type conflict, we would still wonder what this conflict has to do with perfectivity. In other words, unless we could relate the type conflict to the semantics of perfectivity, we would have made little progress in understanding the reason for the conflict.

My harsh evaluation aside, strategy 2 at least has the virtue of raising the possibility that imperfective and perfective verbs in Polish (and Slavic) differ in their logical type—a possibility that has not been considered in the literature, as far as I am aware. In fact, the analysis that I will propose also attributes distinct logical types to perfective and imperfective verbs (though not in the same way as strategy 2), but my account of the aspectual problem crucially does not rest on a type conflict between perfective verbs and noun phrases receiving a bare interpretation.

2.3. Strategy 3: severing the prefix from its verb

A more sophisticated strategy (strategy 3) is suggested by Krifka (1989, 1992) and Verkuyl (1999b,c), who propose that a perfective prefix in Slavic should be represented as an aspectual operator taking scope over the verb phrase. This proposal is depicted in Figure 1, where the perfective prefix appears in Asp, the (prefixless) verb stem in V_{stem}, and the external and internal arguments of the verb are realized in NP_{ext} and NP_{int}, respectively.[5] This structure should be understood as underlying, and an additional mechanism (e.g., head movement) is needed in order to ensure that the verb stem eventually forms a morphological unit with its prefix. Assuming such a structure, the idea is that the perfective operator in Asp imposes a semantic condition on the VP, which in turn has the consequence that NP_{int} cannot be interpreted as a bare noun phrase.

As a general critical remark, let me point out that both Krifka and Verkuyl are heavily biased towards NP_{int}. Krifka effectively ignores the fact that the restriction against bare noun phrases applies to NP_{ext} as well, and Verkuyl is at best ambivalent about how to deal with this. However, until this fact is treated properly, both Krifka's and Verkuyl's analyses fall short of accounting for the relevant data.

Krifka's and Verkuyl's accounts are conceptually very similar. For Krifka the perfective operator requires the VP to be *quantized*, which in his framework has the effect of forcing NP_{int} to be quantized as well. Since noun phrases with a bare interpretation are not quantized, they are thereby ruled out as objects of perfective verbs. For Verkuyl the perfective operator requires the VP to be [+T] (or *terminative*), which in his theory has the consequence that NP_{int} is [+SQA] (or denotes a *specified quantity of A*, where A is the denotation of the head noun).

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[4] More precisely, as $\lambda R \lambda x[\exists y[R(x,y) \wedge Articles(y)]]$.

[5] The exact node labels in Figure 1 are immaterial. This tree is based on Figure 17 of Verkuyl (1999c, 132). To be fair, Krifka would not necessarily endorse this structure. Nevertheless, he (e.g., Krifka 1992, 50) clearly intends for the perfective operator to have scope over the verb phrase. It should be acknowledged that the idea of having the perfective prefix occupy a position above the verb phrase (typically, the head of an aspect phrase) is widespread in the recent syntactic literature on Slavic aspect and goes back at least to Walińska (1990).
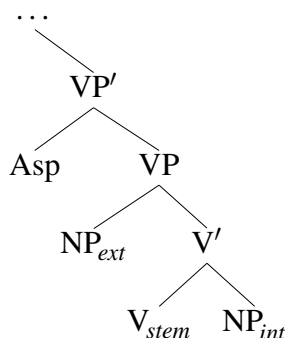
Figure 1: Asp as an operator with scope over the VP

Since noun phrases with a bare interpretation are [−SQA], they are perforce ruled out as objects of perfective verbs.

At least this is the way both of these analyses are *intended* to work. To be frank, it is not clear to me that they actually *do* work as intended, because both authors are sparing in the details, and as I will argue next, it may prove rather difficult to fill in the details so that the analyses are compositional.

The main problem with strategy 3 is that it involves a flagrant violation of lexical integrity. I will not recite the familiar arguments for treating perfective verbs in Polish as lexical units, but it is well-known that the exact choice of perfective prefix is generally not predictable and that the semantic combination of the prefix and the verb is often (even typically) not compositional. I am also not aware of any syntactic evidence in Polish suggesting that verbal prefixes are anywhere but morphologically bound to their respective verbs.[6] Moreover, verbal prefixation is traditionally analyzed as belonging to derivation (and not to inflection) in Polish grammars (e.g., see Grzegorczykowa, Laskowski, and Wróbel 1998), and this for good reasons.

To take just one example, consider the aspectual pair *u·dowodnić*[P]/*u·dowadniać*[i] 'prove' from (3) and (4). Here the perfective verb is basic, and its imperfective counterpart is related to it via the addition of an imperfective suffix (*-a-*) and an alternation in the final vowel of the stem (*o* vs. *a*).[7] (Note that *-ć* is the infinitival suffix.) Now, the difficulty is that although *u·dowodnić*[P] has *u-* as its prefix, there is no verb *dowodnić that *u-* could have combined with.[8] More to the point, consider analyzing the sentence in (3b) in terms of the structure in Figure 1:

(15)   [... [$_{VP'}$ u- [$_{VP}$ Irenka dowodniła twierdzenia]]]   (See (3b))

What meaning should be assigned to the VP if no meaning can be assigned to *dowodnić, given that it does not exist? And yet if no meaning can be assigned to the VP, to what extent is the analysis offered by strategy 3 really compositional? Since there are many verbs like *u·dowodnić*[P] in Polish, I have to reject strategy 3 as unsuccessful until it suggests a convincing way out of this conundrum.[9]

A supporter of strategy 3 might concede that treating the structure in Figure 1 as underlying is not such a happy choice but at the same time contend that we could reconstrue this structure

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[6] Verbal prefixes in Polish are essentially incorporated prepositions historically and it is doubtful that there was ever a stage of the language in which they hovered over the VP.

[7] This raises the question of how strategy 3 would analyze imperfectivization in Slavic—perhaps with an imperfective operator looming over VP′ in Figure 1? However, since the present paper is concerned with perfectivization, I will set this question aside here.

[8] Diachronically, *u·dowodnić*[P] is most likely derived from *dowód* 'proof' through a process of denominalization.

[9] Verkuyl seems to be taken by the idea that the prefix is not attached to the verb stem and even claims (Verkuyl 1999c, 116) that it is misleading to speak of 'perfective verbs' and 'imperfective verbs' as Slavicists have done for decades. Of course, such pronouncements are easy to make as long as one does not take morphology too seriously.

as an LF (i.e., Logical Form) representation. In other words, the prefix would raise to Asp only at LF. More precisely, what would raise is not so much the prefix itself but rather a pristine perfective operator. In this way, a verb such as *u·dowodnić*[P] could be interpreted as a unit *in situ* but its perfective meaning would enter the semantic composition only above the VP.

I must reserve judgment on this less tangible version of strategy 3 until it is worked out. On the face of things, however, it pays a high price in abstraction, because to my knowledge the perfective operator never gives rise to scope ambiguities through interaction with other operators or quantifiers, hence the usual motivation for an LF raising analysis appears to be lacking. Consequently, the advocate of this strategy would have to justify both why the perfective operator must be raised and where it is raised to.

My criticism notwithstanding, the guiding intuition behind strategy 3 is that a perfective prefix in Polish, although morphologically bound to the verb, semantically has the verb phrase or perhaps even the (tenseless) clause in its scope. I find this intuition correct, and so the challenge lies in producing an analysis that captures it without violating the lexical integrity of Polish verbs. I take up this challenge in the next section.[10]

3. A new analysis

I will develop my analysis in an event semantic framework for aspectual composition, much in the style of Krifka (1989, 1992). My aim is to show how an approach such as Krifka's can be revised to account for the Polish facts while at the same time respecting the lexical integrity of Polish verbs. In fact, the revision that I propose is fairly conservative in that it does not introduce anything that his theory does not really already have. The main way that I differ from Krifka is that I analyze verbs as n-place (and sometimes even higher order) relations and not simply as one-place event predicates (as he does). This, in turn, requires me to provide a rather different treatment of NPs than his. While I do not presuppose familiarity with Krifka's approach (although familiarity with it is certainly an advantage), I do have to assume a background in model-theoretic semantics.

3.1. Preliminaries

I will formulate my analysis in an extensional type-theoretic language J_2 with identity, lambda abstraction, and iota descriptions. A *model* for J_2 is a tuple $\langle D, O, E, \dot{\sqsubset}, i \rangle$ with the following characteristics:

- D is a nonempty set of *objects*.

- O and E are nonempty disjoint subsets of D such that O is a set of *physical objects* and E is a set of *events*.

- $\dot{\sqsubset}$ is a *proper part* relation on $D \times D$.

- i is the interpretation function for J_2.

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[10] Filip's (1999) account of Czech aspect might be an instance of strategy 3, but unfortunately it is hard for me to tell. Her analysis of the perfective operator consists of the statement '[PERFECTIVE ϕ] denotes events represented as integrated wholes (i.e., in their totality, as single indivisible wholes)', and she adds that PERFECTIVE is 'a function that maps from any kind of eventuality to a 'total event'' (Filip 1999, 184). However, as far as I can determine the reader is never told what ϕ is (a sentence? an event predicate representing the clause? an event predicate representing the verb?) nor how 'integrated wholes' or 'total events' are to be understood (are 'total events' a kind of event? or a kind of event predicate?). Is PERFECTIVE a defined function? If so, how is it defined? If not, what principles govern it? Until such questions are addressed, it is difficult to regard Filip's analysis of the perfective operator as anything but a fanciful redescription of a common intuition about perfectivity.

Note that the intended sense of 'event' is broad and covers states and processes as well (i.e., what many would call 'eventuality').

For distinctiveness, the constants and variables of J_2 are written in this font. J_2 has the following three sets of individual variables for the elements of D, O, and E, respectively:

- objects (elements of D): a, b, c, ...

- physical objects (elements of O): x, y, z, ...

- events (elements of E): e, e′, e″, ...

In addition, J_2 has a constant '⊏' that corresponds to the proper part relation $\dot{\sqsubset}$.

J_2 has predicate variables of various types. The ones that play a distinguished role in this paper are:

- one-place unsorted predicate variables (of type $\langle e,t \rangle$): P, Q, P′, ...

- n-place unsorted predicate variables, where n is a positive integer (of types $\langle e,t \rangle$; $\langle e\langle e,t \rangle \rangle$; $\langle e\langle e\langle e,t \rangle \rangle \rangle$; etc.): R^n, S^n, $R^{n'}$, ... [11]

- two-place generalized quantifier predicate variables (of type $\langle \langle e, \langle e,t \rangle \rangle, \langle e,t \rangle \rangle$): $\mathscr{P}$, $\mathscr{Q}$, $\mathscr{P}'$, ...

The two-place generalized quantifier predicate variables are relevant for the analysis of NPs, which I discuss in the next section.

I assume that the semantics for J_2 is recursively specified in the standard manner so that for every expression α of J_2, $[\![\alpha]\!]_{M,g}$ is the extension of α in model M relative to assignment function g.

The proper part relation $\dot{\sqsubset}$ obeys certain axioms, which I express in J_2 as constraints on the interpretation of '⊏'. The first two axioms state that the proper relation is asymmetric and transitive:

(16) a. AXIOM. $\forall a \forall b[a \sqsubset b \rightarrow \neg(b \sqsubset a)]$ (asymmetry)
      b. AXIOM. $\forall a \forall b \forall c[a \sqsubset b \wedge b \sqsubset c \rightarrow a \sqsubset c]$ (transitivity)

Notice that these axioms imply that the proper part relation is also irreflexive (and therefore a strict partial order).

With the help of the proper part relation and identity, the usual notions of *part* and *overlap* can be easily defined:

(17) a. $a \sqsubseteq b \overset{\text{def}}{=} a \sqsubset b \vee a = b$
         (*a* is a part of *b*)

      b. $a \circ b \overset{\text{def}}{=} \exists c[c \sqsubseteq a \wedge c \sqsubseteq b]$
         (*a* and *b* overlap)

Use of the overlap relation facilitates the statement of the final two axioms for the proper part relation.

(18) a. AXIOM. $\forall a \forall b[a \sqsubset b \rightarrow \exists c[c \sqsubset b \wedge \neg(c \circ a)]]$ (supplementation)
      b. AXIOM. $\forall P[\exists a[P(a)] \rightarrow \exists a \forall b[b \circ a \leftrightarrow \exists c[P(c) \wedge c \circ b]]]$
         (existence of unique sums)

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[11] The superscript n will be suppressed whenever its value is clear from the context.

Supplementation requires any object that has a proper part to have at least two nonoverlapping proper parts. The axiom in (18b) guarantees that every predicate P with a nonempty extension has a unique *sum*. Basically, the sum of a set *P* is *the* object composed precisely of all the elements of *P*. As a consequence of this axiom, the set *D* in models for J_2 contains many 'mixed' objects that are built out of physical objects and events but which themselves are not physical objects or events. However, there is no harm in having these 'mixed' objects around, even if we are not particularly interested in talking about them.[12]

Since every nonempty set of objects has a unique sum, *the* sum of a predicate P can be defined with the help of the iota descriptor as follows:

(19) $\sigma(P) \overset{\text{def}}{=} \iota a[\forall b[b \circ a \leftrightarrow \exists c[P(c) \wedge c \circ b]]]$
        (the sum of *P*)

Observe that the application of σ will result in an improper description if 'P' denotes the empty set (since the empty set has no sum). For simplicity (to keep the underlying logic bivalent), the iota descriptor can be treated as contextually eliminable in the usual Russellian fashion. This has the consequence that any positive assertion involving '$\sigma(P)$', if 'P' denotes the empty set, will be false.

A special case of sum arises when σ is applied to a predicate denoting a set of objects that are parts of at most two given objects. In this case it is useful to define a binary sum operator that applies directly to the two given objects:

(20) $a \oplus b \overset{\text{def}}{=} \sigma(\lambda c[c \sqsubseteq a \vee c \sqsubseteq b])$
        (the sum of *a* and *b*)

Four further notions play an important role in the analysis to come.[13] The first of these is *cumulative reference*, generalized for *n*-place predicates:

(21) $\text{CUM}(R^n) \overset{\text{def}}{=} \exists a_n \ldots \exists a_1 \exists b_n \ldots \exists b_1 [R^n(a_n, \ldots, a_1) \wedge R^n(b_n, \ldots, b_1) \wedge$
        $\neg(a_n = b_n \wedge \ldots \wedge a_1 = b_1)] \wedge$
        $\forall a_n \ldots \forall a_1 \forall b_n \ldots \forall b_1 [R^n(a_n, \ldots, a_1) \wedge R^n(b_n, \ldots, b_1) \rightarrow R^n(a_n \oplus b_n, \ldots, a_1 \oplus b_1)]$
        (R^n is cumulative)

In prose, cumulative reference states that the extension of a predicate is closed with respect to the binary sum operation (and that its extension contains at least two objects).

The second notion is *quantized reference*, defined for one-place predicates:

(22) $\text{QUA}(P) \overset{\text{def}}{=} \forall a \forall b[P(a) \wedge P(b) \rightarrow \neg(a \sqsubset b)]$
        (*P* is quantized)

More informally, quantized reference states that the extension of a predicate does not extend to proper parts of the objects that it contains.

It is not difficult to see that if a predicate is quantized, then it is not cumulative, i.e., being quantized is a stronger condition than that of not being cumulative:[14]

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[12] The axioms in (16) and (18) define what Simons (1987) calls a *classical extensional mereology*.

[13] The following four notions are taken from Krifka (1992, 32, 39–40), but with the two differences that (i) my definition of cumulative reference corresponds to Krifka's notion of *strictly cumulative reference* and moreover is generalized for *n*-place predicates (whereas his notion of strictly cumulative reference is defined only for one-place predicates), and (ii) my definition of uniqueness of participants corresponds to his notion of *uniqueness of objects*.

[14] Observe that a predicate may be both not cumulative and not quantized. Such an example would be $\lambda x[\text{At-Most-Three-Articles}(x)]$, which denotes the set of sums of objects built out of at most three articles.

(23)   FACT. $\forall P[QUA(P) \rightarrow \neg CUM(P)]$

The third notion is *iterativity*: a two-place relation R is iterative for an event e and a physical object x just in case e stands in relation R to x and furthermore at least two distinct parts of e stand in relation R to some one part of x:

(24) $\text{Iter}(e, x, R) \stackrel{\text{def}}{=} R(e, x) \wedge$
$\quad \exists e' \exists e'' \exists x'[e' \sqsubseteq e \wedge e'' \sqsubseteq e \wedge \neg(e' = e'') \wedge x' \sqsubseteq x \wedge R(e', x') \wedge R(e'', x')]$
$\quad$ (*R* is iterative for *e* and *x*)

The fourth and final notion is *uniqueness of participants*, defined for two-place relations between events and physical objects. In brief, uniqueness of participants states that if e stands in relation R to x, then e does not stand in relation R to any other physical object:

(25) $\text{UNI-P}(R) \stackrel{\text{def}}{=} \forall e \forall x \forall x'[R(e, x) \wedge R(e, x') \rightarrow x = x']$
$\quad$ (*R* satisfies uniqueness of participants)

3.2. Treating NPs

Recall that any analysis of aspectual composition is incomplete without an account of how verbs combine with their NP arguments, and yet this, however, presupposes a treatment of NPs. Although it is beyond the scope of this paper to provide a detailed analysis of NPs, I will indicate the general strategy here, concentrating on the indefinite and definite interpretation of *artykuły* '(the) articles', as illustrated in (1).

In a standard *non*-event-based semantics, NPs are often analyzed as *generalized quantifiers*, i.e., of type $\langle\langle e,t\rangle, t\rangle$, which means that they apply to a one-place predicate and yield a proposition-denoting formula. In an event-based semantics, however, such an analysis falls short in two respects: first, it fails to take account of the fact that the predicate that the generalized quantifier applies to usually has an event argument; and second, it fails to ensure that the result of applying the generalized quantifier to the predicate should normally be an event predicate (and not a proposition-denoting formula). These two shortcomings can be eliminated if NPs are analyzed as two-place predicates between events e and relations R between events and physical objects, as in (26), where $\underline{\mathcal{Q}}$ is a generalized quantifier constant.

(26) $\lambda R \lambda e[\underline{\mathcal{Q}}(e, R)]$ (type $\langle\langle e, \langle e,t\rangle\rangle, \langle e,t\rangle\rangle$)
$\quad$ (format for generalized quantifiers)

In an event-based semantics, then, a generalized quantifier applies to a two-place predicate between events and physical objects and yields a one-place event predicate.

Turning now to the analysis of the two readings of *artykuły* '(the) articles' in (1), I represent the noun *artykuł* 'article' as the one-place predicate Article (as in (27a)) together with the condition that Article is quantized (as in (27b)):

(27)   a. $[_N$ artykuł$]$ 'article' $\rightsquigarrow \lambda x[\text{Article}(x)]$
$\quad$ b.   AXIOM. $QUA(\text{Article})$

I treat the plural suffix -*y* as a modifier that applies to a one-place predicate P of physical objects and yields a predicate that denotes sums built out of physical objects of type *P*:

(28)   -y (plural suffix) $\rightsquigarrow \lambda P \lambda x[x = \sigma(\lambda y[y \sqsubseteq x \wedge P(y)])]$

Combining -*y* with *artykuł* we obtain the following analysis of *artykuły* 'articles':

(29) $[_N \text{artykuły}]$ 'articles' $\leadsto \lambda x[x = \sigma(\lambda y[y \sqsubseteq x \wedge \text{Article}(y)])]$,
    $\overset{\text{def}}{=} \text{Articles}$

It is easy to show that Articles is cumulative as long as there are at least two articles:

(30)   FACT. $\exists x \exists y[\text{Articles}(x) \wedge \text{Articles}(y) \wedge \neg(x = y)] \rightarrow \text{CUM}(\text{Articles})$

The derivation of NPs is usually mediated by a determiner. Although Polish lacks overt articles, it very definitely makes use of the semantic notions of indefiniteness and definiteness. For simplicity (and because nothing crucially depends on it), I treat articles in Polish as phonologically null determiners and analyze the indefinite and definite article as in (31a) and (31b), respectively.

(31)   a. $\varnothing_{indefin} \leadsto \lambda P \lambda R \lambda e[\exists x[P(x) \wedge R(e, x)]]$
    b. $\varnothing_{defin} \leadsto \lambda P \lambda R \lambda e[R(e, \iota x[x = \sigma(P) \wedge P(x)])]$

Whereas the indefinite article introduces existential quantification over physical objects of type *P*, the definite article introduces the sum of physical objects of type *P* with the additional restriction that the sum itself also be of type *P*.

We obtain generalized quantifiers in the sense of (26) by applying each of these determiners to Articles, as seen in (32a) and (32b), respectively.

(32)   a. $[_{NP} \varnothing_{indefin} [_N \text{artykuły}]]$ 'articles' $\leadsto \lambda R \lambda e[\exists x[\text{Articles}(x) \wedge R(e, x)]]$,
        $\overset{\text{def}}{=} \text{Articles}^*$
    b. $[_{NP} \varnothing_{defin} [_N \text{artykuły}]]$ 'the articles' $\leadsto \lambda R \lambda e[R(e, \iota x[x = \sigma(\text{Articles}) \wedge \text{Articles}(x)])]$,
        $\overset{\text{def}}{=} \text{The-Articles}$

It may be thought that since Articles is cumulative (see (30)), it should automatically follow that Articles* is cumulative as well, but unfortunately this is not so, given that the notions of cumulative and quantized reference as defined in (21) and (22) are not applicable to generalized quantifiers. Furthermore, any attempt to define an appropriate notion of cumulative reference for generalized quantifiers has to take into account whether the predicate R satisfies certain properties. With this in mind, we say that a generalized quantifier $\mathscr{P}$ is *cumulative** just in case for any cumulative predicate R that satisfies uniqueness of participants, the result of applying $\mathscr{P}$ to R is cumulative, and where it is required that there be a cumulative R that satisfies uniqueness of participants and that there be at least two distinct events e and e′ that $\mathscr{P}(R)$ applies to such that R is not iterative for the sum of e and e′ and some object x. More precisely, we have:

(33) $\text{CUM}^*(\mathscr{P}) \overset{\text{def}}{=} \exists e \exists e' \exists x \exists R[\text{CUM}(R) \wedge \text{UNI-P}(R) \wedge \mathscr{P}(e, R) \wedge \mathscr{P}(e', R) \wedge \neg(e = e') \wedge$
        $\neg\text{Iter}(e \oplus e', x, R) \wedge$
        $\forall R[\text{CUM}(R) \wedge \text{UNI-P}(R) \rightarrow \text{CUM}(\mathscr{P}(R))]$
        ($\mathscr{P}$ is cumulative*)

With this notion of cumulative* reference in hand, we can prove that Articles* is cumulative*:

(34)   FACT. $\exists e \exists e' \exists x \exists R[\text{CUM}(R) \wedge \text{UNI-P}(R) \wedge \text{Articles}^*(e, R) \wedge \text{Articles}^*(e', R) \wedge$
        $\neg(e = e') \wedge \neg\text{Iter}(e \oplus e', x, R)] \rightarrow \text{CUM}^*(\text{Articles}^*)$

Proof. For a *reductio* assume that Articles* is not cumulative*. Then by (33) there is a cumulative R satisfying uniqueness of participants such that Articles*(R) is not cumulative. By (21) there are distinct e, e′ such that Articles*(e, R), Articles*(e′, R), and $\neg\text{Articles}^*(e \oplus e', R)$ all hold. By (32a) this means that there are (possibly identical) x, y such that $\text{Articles}(x) \wedge R(e, x)$,

Articles$(y) \wedge R(e',y)$, and $\neg(\text{Articles}(x \oplus y) \wedge R(e \oplus e', x \oplus y))$ all hold. However, these all hold only if Articles or R is not cumulative, but this contradicts the premise that both of them *are* cumulative. Therefore, Articles* is cumulative*.

We can also show that The-Articles is not cumulative*. But before demonstrating this, let's take note of the following straightforward fact:

(35)   FACT. $\forall e \forall e' \forall x \forall y \forall z \forall R[\text{CUM}(R) \wedge \text{UNI-P}(R) \wedge R(e,x) \wedge R(e',y) \wedge R(e \oplus e', z) \rightarrow$
        $z = x \oplus y$

And now we state the claim that The-Articles is not cumulative*:

(36)   FACT. $\neg(\text{CUM}^*(\text{The-Articles}))$

Proof. For a *reductio* assume that The-Articles is cumulative*. By (33) there is a cumulative R satisfying uniqueness of participants and there are distinct e, e' such that The-Articles(e,R) and The-Articles(e',R) both hold, and there is an x such that $\neg\text{Iter}(e \oplus e', x, R)$ holds. By (32b) and (35) the x in question is $\iota x[x = \sigma(\text{Articles}) \wedge \text{Articles}(x)]$, and so we have that

$$R(e, \iota x[x = \sigma(\text{Articles}) \wedge \text{Articles}(x)]), R(e', \iota x[x = \sigma(\text{Articles}) \wedge \text{Articles}(x)]),$$

and $R(e \oplus e', \iota x[x = \sigma(\text{Articles}) \wedge \text{Articles}(x)])$ all hold, but notice that this means that R *is* iterative for $e \oplus e'$ and $\iota x[x = \sigma(\text{Articles}) \wedge \text{Articles}(x)]$, contrary to the premise that it is not. Hence there is no such x and we conclude that The-Articles is not cumulative*.

Intuitively, the difference between Articles* and The-Articles is that summing any two distinct events in the extension of the former does not necessarily lead to an iterative reading, whereas summing any two distinct events in the extension of the latter does.

Technically, it would be possible to define an appropriate notion of quantized* reference for generalized quantifiers and then show that it implies the lack of cumulative* reference. However, the appropriate notion of quantized* reference is more involved than that of cumulative* reference, and for the analysis in the next two sections it suffices to stay with the weaker notion of not being cumulative*.

3.3. Treating verbs

For the analysis of verbs it is once again expedient to focus on a specific example. For this purpose I choose the aspectual pair *czytać*$^{\text{i}}$/*prze·czytać*$^{\text{P}}$ 'read' as exhibited in the contrasts in (1) and (2). Generalizing the account to comparable examples is not difficult.

Central to the analysis of *czytać*$^{\text{i}}$/*prze·czytać*$^{\text{P}}$ are three primitive relations: a one-place event predicate Read and two two-place predicates Agent and Patient$_g$ (a.k.a. *thematic relations*) between events and physical objects. The 'g' in 'Patient$_g$' serves as a reminder that not all patients are equal and that our foremost concern is with patients of reading events (what Krifka calls *gradual patients*). We require that all three of these predicates be cumulative:

(37)   AXIOM. $\text{CUM}(\text{Read}) \wedge \text{CUM}(\text{Agent}) \wedge \text{CUM}(\text{Patient}_g)$

Furthermore, both Agent and Patient$_g$ should satisfy uniqueness of participants (see (25)):

(38)   AXIOM. $\text{UNI-P}(\text{Agent}) \wedge \text{UNI-P}(\text{Patient}_g)$

A natural condition on reading events is that they each should have an agent and a patient participant:

(39)   AXIOM. $\forall e[\text{Read}(e) \rightarrow \exists x[\text{Agent}(e,x)] \wedge \exists y[\text{Patient}_g(e,y)]]$

Allowing for a little idealization, it seems reasonable to say that if a reading event *e* has a physical object *x* as its patient, then any subevent *e′* of *e* has a part *x′* of *x* as *its* patient. In other

words, the parts of a reading event are directed at parts of the patient. This property is known as *mapping to objects*:

(40) $\text{MAP-O}(R) \stackrel{\text{def}}{=} \forall e \forall e' \forall x [R(e,x) \wedge e' \sqsubseteq e \rightarrow \exists x' [x' \sqsubseteq x \wedge R(e',x')]]$
         (*R* satisfies mapping to objects)

I point out that mapping to objects as defined is fairly innocuous, because it always allows (as a limiting case) for every subevent e' to be mapped to the same x', namely x. It is precisely this innocuous feature that permits us to say that both Agent and Patient_g should satisfy mapping to objects:

(41)   AXIOM. $\text{MAP-O}(\text{Agent}) \wedge \text{MAP-O}(\text{Patient}_g)$

The value of introducing mapping to objects is that it enables us to conclude that every proper subevent e' of e is mapped to a proper part x' of x just in case the thematic relation in question is not iterative for e and x. We see this below in (45).

The inverse property of mapping to objects is *mapping to events*. In terms of reading events, it states that if an object x is the patient of a reading event e, then every part x' of x is the patient of a subevent e' of e. In other words, no part of the patient goes unread.

(42) $\text{MAP-E}(R) \stackrel{\text{def}}{=} R(e,x) \wedge x' \sqsubseteq x \rightarrow \exists e' [e' \sqsubseteq e \wedge R(e',x')]$
         (*R* satisfies mapping to events)

As just implied, Patient_g should satisfy mapping to events (but Agent should not, given that not all parts of the agent of a reading event are agents of a reading event):

(43)   AXIOM. $\text{MAP-E}(\text{Patient}_g)$

Strictly speaking, although mapping to events allows (as a limiting case) every part of the patient x of a reading event e to be mapped to the very same reading event (namely e), this possibility is ruled out by uniqueness of participants. In particular, we can infer that any proper part of x is mapped to a proper subevent of e:

(44)   FACT. $\forall e \forall x \forall x' [\text{Patient}_g(e,x) \wedge x' \sqsubset x \rightarrow \exists e' [e' \sqsubset e \wedge \text{Patient}_g(e',x')]]$

If an object x is the patient of a reading event e and no part of x is read more than once, then mapping to objects (see (40) and (41)) allows us to conclude that every proper part e' of e has a proper part x' of x as its patient:

(45)   FACT. $\text{Patient}_g(e,x) \wedge \neg\text{Iter}(e,x,\text{Patient}_g) \wedge e' \sqsubset e \rightarrow \exists x' [x' \sqsubset x \wedge \text{Patient}_g(e',x')]$

In principle, the same result obtains for Agent, but since agents generally *are* iterative (i.e., the agent of an event is usually the agent of any of its subevents), it is not of practical interest.

Moving towards Polish, let's define a three-place predicate Read^+ as the conjunction of Read, Agent, and Patient_g:

(46) $\text{Read}^+(e,x,y) \stackrel{\text{def}}{=} \text{Read}(e) \wedge \text{Agent}(e,x) \wedge \text{Patient}_g(e,y)$

It is easy to see that Read^+ is cumulative (given that its component predicates are):

(47)   FACT. $\text{CUM}(\text{Read}^+)$

I propose to analyze the Polish verb root *czyt-* 'read' as the predicate Read^+:

(48)   *czyt-* 'read' (verb root) $\rightsquigarrow \text{Read}^+$

This is effectively the analysis that Krifka proposes for *read* (and German *lesen*),[15] but as an analysis of either *czytać*$^\text{i}$ or *prze·czytać*$^\text{p}$ it will not do. On the one hand, the meaning of *czytać*$^\text{i}$ allows but does not require all of (the referent of) its internal argument to be read, whereas Read$^+$ requires all of (the referent of) its internal argument to be read. On the other hand, the meaning of *prze·czytać*$^\text{p}$ somehow prohibits its NP arguments from receiving a bare interpretation, whereas there is nothing about Read$^+$ that would have this consequence.

I suggest that the meaning of *czytać*$^\text{i}$ is related to that of the verb root *czyt-* via the addition of an imperfective operator. It is convenient, though not strictly necessary, to treat the 'thematic suffix' of the Polish verb as the morphological exponent of an imperfective operator. In the case of *czyt-* the thematic suffix is *-a-*, which I analyze as follows:

(49)   -a- (imperfective suffix) $\rightsquigarrow \lambda R \lambda y \lambda x \lambda e[\exists y'[y' \sqsubseteq y \wedge R(e,x,y')]]$,
       $\overset{\text{def}}{=} \text{Impf}_1$

Combining *-a-* with *czyt-* via functional application we arrive at the following analysis of *czytać*$^\text{i}$ (notice that I treat the infinitival suffix *-ć* as semantically empty):[16]

(50)   czytać$^\text{i}$ 'read' $\rightsquigarrow \text{Impf}_1(\text{Read}^+) = \lambda y \lambda x \lambda e[\exists y'[y' \sqsubseteq y \wedge R(e,x,y')]]$,
       $\overset{\text{def}}{=} \text{Impf}_1\text{-Read}^+$

According to this analysis, *czytać*$^\text{i}$ denotes events *e* in which *x* reads a part *y'* of *y*. Essentially, this is a partitive analysis of *czytać*$^\text{i}$ with respect to its internal argument *y*. Observe that the analysis allows but does not require *x* to read all of *y* in *e*, as desired. If *x* does read all of *y* in *e*, then *y* is the patient of *e*; otherwise, only a proper part of *y* is the patient of *e*. Another way of putting this is that the meaning of $\text{Impf}_1\text{-Read}^+$ applied to *e*, *x*, and *y* together with the condition that every part of *y* participate in *e* is equivalent to just the meaning of Read$^+$ applied to *e*, *x*, and *y*:

(51)   FACT. $\forall e \forall x \forall y[\text{Impf}_1\text{-Read}^+(e,x,y) \wedge \forall y'[y' \sqsubseteq y \rightarrow \exists e'[e' \sqsubseteq e \wedge$
       $\text{Impf}_1\text{-Read}^+(e',x,y')]] \leftrightarrow \text{Read}^+(e,x,y)]$

The significance of the '1' in 'Impf_1' is to suggest that there is more than one imperfective operator in Polish—I do not claim that the (partitive) analysis in (49) does duty for all instances of the imperfective. Furthermore, the analysis in (50) is meant to capture the *activity* interpretation (in Vendler's (1967) terms) of *czytać*$^\text{i}$ and not its progressive meaning.

Verbal prefixes in Polish are morphological exponents of a perfective operator. In the case of *prze·czytać*$^\text{p}$ this is *prze-*, which I analyze as in Figure 2. Applied to a three-place predicate R between events and two physical objects, *prze-* yields a three-place predicate between events and two generalized quantifiers with the additional requirements that all parts of the referent of the internal argument of R participate in the event and that the result of adding either generalized quantifier not be cumulative.

Again, the '1' in Pf_1 is a reminder that we are concerned with the meaning of a specific prefix and not of an all-purpose perfective operator. For example, the assertion of *prze-* in this

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[15] Krifka actually analyzes *read* and German *lesen* as Read (i.e., as a one-place event predicate), but it is fair to say that he would analyze them as Read$^+$ if he were to analyze verbs as *n*-place predicates. As I said at the outset, I do not follow Krifka in treating verbs as one-place event predicates.

[16] It may be simplistic to think of the thematic suffix as the morphological exponent of imperfectivity, as Uwe Junghanns has kindly emphasized to me. Although discussion of this point would take me too far afield, the idea can be stated more generally as follows: imperfectivity is a property of the verb stem (= verb root + thematic suffix) and not of the verb root alone. The fact that certain verb stems lack a thematic suffix and are therefore morphologically identical with their verb roots is not an insuperable difficulty for this idea. At the same time, however, nothing in the present analysis crucially depends on this idea being correct.

prze- (perfective prefix) ⤳
$\quad \lambda R \lambda \mathcal{Q} \lambda \mathcal{P} \lambda e[\mathcal{P}(e, \lambda x \lambda e'[\mathcal{Q}(e', \lambda y \lambda e''[R(e'', x, y) \wedge$
$\qquad \forall y'[y' \sqsubseteq y \rightarrow \exists e_1[e_1 \sqsubseteq e'' \wedge R(e_1, x, y')]]] \wedge$
$\qquad \forall x[\neg \mathsf{CUM}(\mathcal{Q}(\lambda y \lambda e'[R(e', x, y) \wedge \forall y'[y' \sqsubseteq y \rightarrow \exists e_1[e_1 \sqsubseteq e' \wedge R(e_1, x, y')]]]))] \wedge$
$\qquad \forall y[\neg \mathsf{CUM}(\mathcal{P}(\lambda x \lambda e'[R(e', x, y) \wedge \forall y'[y' \sqsubseteq y \rightarrow \exists e_1[e_1 \sqsubseteq e' \wedge R(e_1, x, y')]]]))]],$
$\overset{\text{def}}{=} \mathsf{Pf}_1$

Figure 2: Analysis of *prze-* (a perfective prefix)

prze·czytać$^\mathsf{P}$ 'read' ⤳ $\mathsf{Pf}_1(\mathsf{Impf}_1\text{-}\mathsf{Read}^+) =$
$\quad \lambda \mathcal{Q} \lambda \mathcal{P} \lambda e[\mathcal{P}(e, \lambda x \lambda e'[\mathcal{Q}(e', \lambda y \lambda e''[\mathsf{Impf}_1\text{-}\mathsf{Read}^+(e'', x, y) \wedge$
$\qquad \forall y'[y' \sqsubseteq y \rightarrow \exists e_1[e_1 \sqsubseteq e'' \wedge \mathsf{Impf}_1\text{-}\mathsf{Read}^+(e_1, x, y')]]]]) \wedge$
$\qquad \forall x[\neg \mathsf{CUM}(\mathcal{Q}(\lambda y \lambda e'[\mathsf{Impf}_1\text{-}\mathsf{Read}^+(e', x, y) \wedge$
$\qquad \forall y'[y' \sqsubseteq y \rightarrow \exists e_1[e_1 \sqsubseteq e' \wedge \mathsf{Impf}_1\text{-}\mathsf{Read}^+(e_1, x, y')]]]))] \wedge$
$\qquad \forall y[\neg \mathsf{CUM}(\mathcal{Q}(\lambda x \lambda e'[\mathsf{Impf}_1\text{-}\mathsf{Read}^+(e', x, y) \wedge$
$\qquad \forall y'[y' \sqsubseteq y \rightarrow \exists e''[e'' \sqsubseteq e' \wedge \mathsf{Impf}_1\text{-}\mathsf{Read}^+(e'', x, y')]]]))]] = \text{ (by (51))}$
$\quad \lambda \mathcal{Q} \lambda \mathcal{P} \lambda e[\mathcal{P}(e, \lambda x \lambda e'[\mathcal{Q}(e', \lambda y \lambda e''[\mathsf{Read}^+(e'', x, y)])]) \wedge$
$\qquad \forall x[\neg \mathsf{CUM}(\mathcal{Q}(\lambda y \lambda e'[\mathsf{Read}^+(e', x, y)]))] \wedge$
$\qquad \forall y[\neg \mathsf{CUM}(\mathcal{P}(\lambda x \lambda e'[\mathsf{Read}^+(e', x, y)]))]],$
$\overset{\text{def}}{=} \mathsf{Pf}_1\text{-}\mathsf{Impf}_1\text{-}\mathsf{Read}^+$

Figure 3: Analysis of *prze·czytać$^\mathsf{P}$* 'read'

case that all parts of the referent of the internal argument participate in the event is certainly not made by the meaning of all perfective prefixes.

The result of applying *prze-* to *czytać$^\mathrm{i}$* is detailed in Figure 3. Notice that I make use of the equivalence in (51) in reducing the formula in the second half of the derivation.

The following fact, which figures centrally in my analysis, states that if the predicate in Figure 3 applies to e, $\mathcal{P}$, and $\mathcal{Q}$, then neither $\mathcal{P}$ nor $\mathcal{Q}$ is cumulative*:

(52) FACT. $\forall e \forall \mathcal{P} \forall \mathcal{Q}[\mathsf{Pf}_1\text{-}\mathsf{Impf}_1\text{-}\mathsf{Read}^+(e, \mathcal{P}, \mathcal{Q}) \rightarrow \neg(\mathsf{CUM}^*(\mathcal{Q}) \vee \mathsf{CUM}^*(\mathcal{P}))]$

Proof. Here I show only that $\mathcal{Q}$ is not cumulative*, since the reasoning involved in showing that $\mathcal{P}$ is not cumulative* is analogous.

For a *reductio* assume that $\mathcal{Q}$ is cumulative*. Then by (33) it follows that for any cumulative R satisfying uniqueness of participants, $\mathcal{Q}(R)$ is cumulative. Observe, though, that the definition of $\mathsf{Pf}_1\text{-}\mathsf{Impf}_1\text{-}\mathsf{Read}^+$ in Figure 3 entails that $\mathcal{Q}(\lambda y \lambda e'[\mathsf{Read}^+(e', x, y)])$ is not cumulative, for any x. Since $\lambda y \lambda e'[\mathsf{Read}^+(e', x, y)]$ is cumulative and satisfies uniqueness of participants, we derive a contradiction, and so $\mathcal{Q}$ is not cumulative*.

We can also show that the result of combining $\mathsf{Pf}_1\text{-}\mathsf{Impf}_1\text{-}\mathsf{Read}^+$ with both of its generalized quantifier arguments is not cumulative:

(53) FACT. $\forall \mathcal{P} \forall \mathcal{Q}[\neg \mathsf{CUM}(\mathsf{Pf}_1\text{-}\mathsf{Impf}_1\text{-}\mathsf{Read}^+(\mathcal{Q})(\mathcal{P}))]$

Remark on proof. For a *reductio* assume that $\mathsf{Pf}_1\text{-}\mathsf{Impf}_1\text{-}\mathsf{Read}^+(\mathcal{Q})(\mathcal{P})$ is cumulative and show that this requires $\mathcal{P}$ to be cumulative*, contrary to the fact in (52).

Recalling the unacceptability of examples such as (8b) and (9b), the fact in (53) suggests that durative adverbials require the event predicates that they modify to be cumulative, which is also consistent with a claim that Krifka (1992, 42) makes in passing about durative adverbials. Given that *prze·czytać$^\mathsf{P}$* always yields event predicates that are not cumulative, it (or the verb phrase that it heads) is predicted to be incompatible with durative adverbials.

The general analysis proposed here does not require that perfective verbs be derived from

imperfective verbs via the addition of a perfective operator, although it is convenient to think of the matter in this way in the case of *czytać*^{i}/*prze·czytać*^{P} and other pairs where the relationship between the prefixed and the unprefixed forms is both morphologically and semantically transparent. For example, there is no obstacle to analyzing *u·dowodnić*^{P} 'prove' as in (54b), without suggesting that the prefix *u-* has semantically applied to **dowodnić* (recall the discussion of *u·dowodnić*^{P}/*u·dowadniać*^{i} in section 2.3).

(54) a. $\mathsf{Prove}^+(e,x,y) \stackrel{\mathrm{def}}{=} \mathsf{Prove}(e) \wedge \mathsf{Agent}(e,x) \wedge \mathsf{Patient}(e,y)$

  b. u·dowodnić^P 'prove' $\rightsquigarrow$
$$\lambda\mathscr{Q}\lambda\mathscr{P}\lambda e[\mathscr{P}(e,\lambda x\lambda e'[\mathscr{Q}(e',\lambda y\lambda e''[\mathsf{Prove}^+(e'',x,y)])]) \wedge$$
$$\forall x[\neg\mathsf{CUM}(\lambda e'[\mathscr{Q}(e',\lambda y\lambda e''[\mathsf{Prove}^+(e'',x,y)])])] \wedge$$
$$\forall y[\neg\mathsf{CUM}(\lambda e'[\mathscr{P}(e',\lambda x\lambda e''[\mathsf{Prove}^+(e'',x,y)])])]]$$

Nevertheless, perfective verbs do have something in common semantically, as a comparison of the formulas in (54b) and Figure 3 reveals. What they share, from the present perspective, is that they apply to generalized quantifiers in lieu of individual arguments and furthermore require that the combination of the verb with either quantifier result in an event predicate that is not cumulative.

3.4. An example

To see the analysis developed above in action, let's apply it to (1b) and show how the interpretation of the object NP *artykuły* '(the) articles' as a bare plural is not admissible, whereas its interpretation as a definite is.

In the previous two sections analyses were provided for *prze·czytać*^{P} 'read' and the two readings of *artykuły* '(the) articles', but *Basia* 'Basia' has not yet been dealt with. This omission is rectified by the following analysis of *Basia* as a generalized quantifier:

(55) [$_{\mathrm{NP}}$ Basia] 'Basia' $\rightsquigarrow \lambda R\lambda e[R(e,\mathsf{Basia})]$,
  $\stackrel{\mathrm{def}}{=} \mathsf{Basia}^*$

The quantifier Basia^* is like $\mathsf{The\text{-}Articles}$ (cf. (36)) in that it is not cumulative*:

(56) FACT. $\neg\mathsf{CUM}^*(\mathsf{Basia}^*)$

The following list summarizes the analyses attributed to the verb and the two NPs of (1b):

- [$_{\mathrm{V}}$ prze·czytać^P] 'read' $\rightsquigarrow \lambda\mathscr{Q}\lambda\mathscr{P}\lambda e[\mathsf{Pf_1\text{-}Impf_1\text{-}Read}^+(e,\mathscr{P},\mathscr{Q})]$ (See Figure 3)

- [$_{\mathrm{NP}} \varnothing_{indefin}$ [$_{\mathrm{N}}$ artykuły]] 'articles' $\rightsquigarrow \lambda R\lambda e[\mathsf{Articles}^*(e,R)]$ (See (32a))

- [$_{\mathrm{NP}} \varnothing_{defin}$ [$_{\mathrm{N}}$ artykuły]] 'the articles' $\rightsquigarrow \lambda R\lambda e[\mathsf{The\text{-}Articles}(e,R)]$ (See (32b))

- [$_{\mathrm{NP}}$ Basia] 'Basia' $\rightsquigarrow \lambda R\lambda e[\mathsf{Basia}^*(e,R)]$ (See (55))

Since tense is irrelevant to the problem at hand, it will be ignored in what follows.[17]

Let's first try to derive the (would-be) reading of (1b) on which *artykuły* is interpreted as a bare plural. Of course, (1b) lacks this reading, and the analysis should predict this. The event predicate representing the (tenseless) clause (here: the subject-internal VP) in (1b) is straightforwardly composed by functionally applying $\mathsf{Pf_1\text{-}Impf_1\text{-}Read}^+$ to both $\mathsf{Articles}^*$ and Basia^* (in that order):

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[17] In the present framework, tense (when realized as a verbal suffix, as in the case of the past tense in Polish) would be most naturally treated as a verbal modifier that restricts the times of the events in the denotation of the verb to be in the past, present, or future, depending on the tense in question.

(57) *$[_{VP} [_{NP}$ Basia$] [_{V'} [_V$ prze·czytać$^P] [_{NP} \varnothing_{indefin} [_N$ artykuły$]]]]]$
　　　'Basia read articles' $\rightsquigarrow \lambda e[Pf_1\text{-}Impf_1\text{-}Read^+(e, Basia^*, Articles^*)]$

What we want to show is that the set of events denoted by this predicate is empty. This is guaranteed by the following fact:

(58) FACT. $\forall \mathscr{P}[\neg\exists e[Pf_1\text{-}Impf_1\text{-}Read^+(e, \mathscr{P}, Articles^*)]]$

Proof. For a *reductio* assume that there is an e such that $Pf_1\text{-}Impf_1\text{-}Read^+(e, \mathscr{P}, Articles^*)$ holds, bearing in mind that $\lambda y \lambda e[Read^+(e, x, y)]$ is cumulative and satisfies uniqueness of participants. By the fact in (52) it follows that Articles* is not cumulative*. But this contradicts the fact in (34), which states that Articles* is cumulative*. Consequently, there is no e that meets the initial condition.

　　Thus, the unacceptability of the reading of (1b) on which *artykuły* is interpreted as a bare plural is captured by the fact that any attempt to combine $Pf_1\text{-}Impf_1\text{-}Read^+$ with Articles* yields an event predicate denoting the empty set.

　　The (acceptable) reading of (1b) on which *artykuły* is interpreted as a definite is represented as in (59) but with the difference that the first argument of $Pf_1\text{-}Impf_1\text{-}Read^+$ is now The-Articles:

(59) $[_{VP} [_{NP}$ Basia$] [_{V'} [_V$ prze·czytać$^P] [_{NP} \varnothing_{defin} [_N$ artykuły$]]]]]$
　　　'Basia read the articles' $\rightsquigarrow \lambda e[Pf_1\text{-}Impf_1\text{-}Read^+(e, Basia^*, The\text{-}Articles)]$

In contrast to the event predicate in (57), this predicate does not necessarily denote the empty set. Although the fact in (52) implies that neither The-Articles nor Basia* in (59) is cumulative*, this accords with the fact that neither The-Articles nor Basia* is actually cumulative* (see (36) and (56)). Thus, nothing excludes the reading of (1b) on which the *artykuły* is interpreted as a definite, as desired.

　　It should be evident that the example in (2b) can be handled in the same way as (1b) but with the difference that the ambiguity now turns on how the subject NP *studenci* '(the) students' is interpreted.

4.　Conclusion

I began with a problem of aspectual composition in Polish, namely, that perfective verbs prohibit their syntactically bare plural or bare singular mass noun phrase arguments from receiving a bare interpretation, and discussed three strategies for solving this problem all of which I argued are unsuccessful as they stand. The analysis that I propose borrows from strategy 2 the idea that perfective and imperfective verbs differ in their logical type (though *how* they differ in their logical type is not the same as in strategy 2): whereas imperfective verbs basically take individual arguments, perfective verbs basically take generalized quantifier arguments. I say 'basically' because if my analysis is correct, then perfective verbs take generalized quantifier arguments *essentially*, i.e., they simply *cannot* take individual arguments and still demand of them what they demand of their generalized quantifier arguments. This idea in turn allows me to capture the guiding intuition behind strategy 3, namely, that perfective prefixes seem to have (semantic) scope over both the verb and its arguments. By having perfective verbs take generalized quantifier arguments, I can capture this intuition without assuming that perfective prefixes are anywhere but morphologically attached to their respective verb stems, just as one would naively expect: no raising, lowering, or whatnot of prefixes is required (or desired). Accordingly, violations of lexical integrity, which were seen to plague strategy 3, simply do not arise. In the proposed analysis, perfective verbs have a kind of 'anti-cumulativity' condition built into their meanings: this condition requires that the result of combining the verb with any generalized quantifier argument not be cumulative. It is due to this condition that we can show both that a perfective verb's generalized quantifier arguments are not cumulative* (see the fact in

(52) for *prze·czytać*ᴾ 'read') and that the result of combining the verb with all of its generalized quantifier arguments is not cumulative (see the fact in (53), again for *prze·czytać*ᴾ).

There are two main objections that I can readily imagine to this analysis. The first is that lack of cumulative reference is not quite the notion that we are after. For example, one might think that lack of cumulative reference is too weak and that quantized reference would be more appropriate. Let me emphasize that there is nothing about the *structure* of the proposed analysis that could not accommodate a notion such as quantized reference instead. Of course, many details would change if I were to use quantized reference instead of cumulative reference, but the general structure of the analysis would remain the same.[18] How to decide *which* notion (whether quantized reference, lack of cumulative reference, or still something else) is the most appropriate for the analysis of Polish aspect is another (in fact, quite difficult) question and one that I do not directly address in this paper.

The second objection is empirical and states that not all perfective verbs in Polish exhibit the restriction that I began with. This is imaginable, even if clear counterexamples are rather hard to detect. Strictly speaking, though, it is not a theorem of the proposed analysis that all perfective verbs pattern like *prze·czytać*ᴾ. I believe that most perfective verbs do pattern in this way, but it is an empirical question whether they all do. In this regard, I suspect that *achievements* (in Vendler's (1967) terms) may behave differently, but I will leave this as an open question here.[19]

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[18] In this connection recall the final remark of section 3.2.

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