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## Aspectual composition and the 'pfective' in Polish

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### 1 Preliminaries

In this paper, I present a new analysis of what I will call the 'pfective' in Polish.<sup>1</sup> Many imperfective verbs in Polish, as other Slavic languages, have both a pfective and a standard perfective counterpart. This is exemplified in (1), where imperfective *czytać* 'read' and perfective *prze-czytać*<sup>P</sup> in (1a-b) are traditionally considered to constitute an aspectual pair, and *po-czytać* in (1c) is the pfective form based on the imperfective.<sup>2</sup>

- (1) a. Irenka czytała wczoraj gazetę.  
Irenka read yesterday newspaper.ACC  
'Irenka read the newspaper yesterday.'
- b. Irenka prze-czytała wczoraj gazetę.  
'Irenka read the newspaper yesterday.'
- c. Irenka po-czytała wczoraj gazetę.  
'Irenka read the newspaper (for a while) yesterday.'

The prefix *po-* of the pfective is a marker of temporal delimitation. It is Grapin's (1949, 267) *po-* of "courte durée," the intuition being that pfective

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<sup>1</sup>The term 'pfective' is due to Galton (1984, 82), who—in an otherwise non-Slavic study—alludes to the analogous phenomenon in Russian. Other terms in use for pfective verbs in Russian are 'attenuative' (Forsyth 1970, 22), 'delimitive' (Flier 1985), 'delimitative' (Smith and Rappaport 1991).

<sup>2</sup>Gloss conventions are: ACC = accusative, GEN = genitive, LOC = locative. Raised 'r' designates an imperfective verb, and raised 'p', a perfective verb. The dot '.' separates a prefix from its verb stem, contrary to orthographic practice. '#' indicates semantic anomaly on the intended reading, and '\*' marks ungrammaticality.

verbs describe situations that last only a relatively short time.<sup>3</sup> Agrell (1908, 65) notes that *po-* has the function of marking an indefinite and usually short action without reference to its beginning or endpoints. Similarly, Grzegorzczkova *et al.* (1984, 474) remark that we interpret perfective verbs without an overt temporal adverbial as naming actions that fill a relatively small space of time. Piernikarski (1975, 31), in a lexical semantic study on the polysymy of *po-*, identifies short temporal measure as one of its central senses. To capture the essence of these intuitions, I translate unmodified perfective verbs with the temporal phrase *for a while*, as in (1c).<sup>4</sup>

I want to ask how perfective verbs relate to the traditional aspectual division between perfectivity and imperfectivity. On the one hand, perfective verbs clearly pattern with perfective verbs, a claim supported by reliable aspectual tests in Polish, demonstrated in §3. On the other hand, perfective verbs, like imperfective verbs and unlike most perfective verbs, describe situations that do not culminate. This is argued in §4. Consequently, any treatment of perfective verbs should account for their mixed nature, which exhibits characteristics of both perfectivity and imperfectivity.

My analysis is grounded in a certain conception of aspectual semantics, the basics of which I will outline here. It is customary in formal semantics to distinguish between natural language, the semantic representation language, and the denotational level. Expressions of natural language are translated into expressions of the semantic representation language, which are then interpreted relative to a model  $\mathbb{M}$  and an assignment function  $g$ . In the simplest case, a model  $\mathbb{M}$  is a pair  $\langle M, \llbracket \cdot \rrbracket \rangle$ , where  $M$  is a set of entities, called the *universe of discourse*, and  $\llbracket \cdot \rrbracket$  is the *interpretive function* that assigns a denotation in  $M$  to the individual and predicate *constants* of the semantic representation language. The assignment function  $g$  assigns a denotation in  $M$  to *variables* in expressions of the semantic representation language.<sup>5</sup> If  $\alpha'$  is the translation in the semantic representation language of a natural language expression  $\alpha$ , it is usual to write  $\llbracket \alpha' \rrbracket^{\mathbb{M}, g}$  for the denotation of  $\alpha'$  relative to the model  $\mathbb{M}$  and assignment function  $g$ .<sup>6</sup>

<sup>3</sup>The other central meaning of *po-* as a marker of distributivity is ignored in this paper. I am not (yet) convinced that it is semantically related to the perfective synchronically.

<sup>4</sup>Cf. Smith and Rapaport (1991, 321) on Russian: "The delimitative prefix *po-* indicates a shorter period than expected."

<sup>5</sup>The universe of discourse (here:  $M$ ) includes all those first-order entities that can be quantified over.

<sup>6</sup>This is an extensional model, i.e., expressions are evaluated with respect to the actual world.

In event semantics (Krifka 1989a–b, Parsons 1990), the universe of discourse is enriched with a variety of entities, standardly called *sorts*. In the present paper, I assume four sorts in the universe of discourse, viz., *objects* (including persons), *times*, *real numbers*, and *eventualities*.<sup>7</sup> Each of these is a set of entities, designated by  $O$ ,  $T$ ,  $R$ , and  $V$ , respectively. Crucially, these sets are pairwise disjoint, i.e., for all  $X, Y \in \{O, T, R, V\}$ ,  $X \neq Y$ ,  $X \cap Y = \emptyset$ , hence any entity belongs to one sort only. The sort of eventualities contains two subsorts, *processes* and *events*.<sup>8</sup> Although the set of processes  $P$  and the set of events  $E$  are disjoint, their union is the full set of eventualities  $V$  (i.e.,  $P \cap E = \emptyset$ ,  $P \cup E = V$ ). I do not consider *states* to be a subsort of eventuality; instead, they are reconstructed as properties of times.<sup>9</sup> Intuitively, events consist of a transition from one state or process to another (they are internally heterogeneous), whereas processes lack such a transition, being internally homogenous down to their minimal parts, which may differ for different types of processes. To summarize, the basic model that I assume is  $\mathbb{M} = \langle O, T, R, P \cup E, \llbracket \cdot \rrbracket \rangle$ .<sup>10</sup> More structure will be attributed to the universe of discourse in §5.

Let us now consider a basic analysis of Polish verbs. I follow Krifka 1989a–b in analyzing verbs and VPs as one-place predicates of eventualities. Given this strategy, what does it mean to be an imperfective verb? I claim that non-stative imperfective verbs like *czytać* in (1a) denote sets of processes—in this case, the set of reading processes. Since processes are crucially distinct from events, no reading event is in the denotation of *czytać*. Most perfective verbs, in contrast, denote events and not processes. Thus *prze-czytać* in (1b) denotes the set of reading events, and no reading process is in its denotation. Finally, stative verbs denote a set of temporal intervals, e.g., *kochać* 'love' denotes the set of temporal intervals at which a loving holds. Formally, these verbs are translated into the representation language as follows:<sup>11</sup>

<sup>7</sup>The term 'eventuality' is due to Bach 1981. I depart from Bach's conception, however, in not taking states to be a type of eventuality, though nothing here crucially depends on this decision.

<sup>8</sup>The idea of introducing events into the universe of discourse is due to Davidson 1967.

<sup>9</sup>See Herweg 1991 for this view on states. However, Herweg does not recognize processes as distinct from both events proper and states, which I believe is incorrect.

<sup>10</sup>As I am concerned with an extensional fragment of Polish, I dispense with a set of worlds.

<sup>11</sup>Although I use Polish forms to render predicates in the semantic representation language, it is important to remember that the representation language is not language-specific, i.e., I could just as well use *leer1* and *leer2* for *czytać* and *prze-czytać*, respectively (Spanish *leer* = 'read').

- (2)
- $czyta^d \Rightarrow \lambda p[\text{czyta}^d(p)]$  (type  $\langle e, t \rangle$ ) 'read'
  - $prze-czyta^d \Rightarrow \lambda e[\text{prze-czyta}^d(e)]$  (type  $\langle e, t \rangle$ ) 'read'
  - $kocha^d \Rightarrow \lambda t[\text{kocha}^d(t)]$  (type  $\langle e, t \rangle$ ) 'love'
- (where  $p, e, t$ , are sorted variables for the elements of  $P, E, T$ , respectively)

Each verb in (2) is represented as a (characteristic) function from entities to truth values. In (2a), for example, we use the assignment function  $g$  to assign values from  $P$  to the process variable  $p$ . The resulting proposition,  $czyta^d(p)$ , where  $p$  is a process constant, is true iff  $p$  is a reading process; otherwise, it is false (e.g., if  $p$  is an eating process). The functions in (2b–c) work the same way.

I offer two arguments in support of the view that the denotations of  $czyta^d$  and  $prze-czyta^d$  differ in this way. First, durative adverbials like *jedną godzinę* 'for one hour' are acceptable with  $czyta^d$  and unacceptable with  $prze-czyta^d$ , whereas exactly the opposite pattern holds for time-span adverbials like *w jedną godzinę* 'in one hour'. Consider the contrast in (3).

- (3)
- Irenka czytała<sup>1</sup> gazetę      jedną godzinę      /  
Irenka read      newspaper.ACC      one.ACC hour.ACC  
\*w jedną      godzinę.  
in one.ACC hour.ACC
  - Irenka read [at] the newspaper for one hour / #in one hour.  
'Irenka prze-czytała<sup>2</sup> gazetę w jedną godzinę / \*jedną godzinę.  
'Irenka read the newspaper in an hour / #for an hour.'

If the meaning of durative adverbials is to measure the duration of processes, and the meaning of time-span adverbials, to measure the duration of events, then the contrast in (3) can be straightforwardly accounted for.<sup>12</sup> If, as claimed above, the denotation of  $czyta^d$  denotes the set of reading processes, then the DP *gazeta* 'a/the newspaper' restricts this set to that proper subset of reading processes in which a/the newspaper is the object read.<sup>13</sup> Formally, the relation

$$[[czyta^d\text{-}gazetę\text{ VP}]]^{\mathcal{M},g} \subset [[czyta^d\text{ V}]]^{\mathcal{M},g} \subset P$$

holds. A parallel account can be given for  $prze-czyta^d$ : the DP *gazeta* restricts the set of reading events to that subset of reading events in which a/the newspaper is the object read.

<sup>12</sup>Dowty 1979 analyzes durative and time-span adverbials in an interval semantics. I must forego comparisons in this paper.

<sup>13</sup>Recall that Polish lacks definite and indefinite articles, therefore such DPs are ambiguous.

Imperfective verbs often appear to denote events as well. For example, (3a) could be uttered to describe a reading eventuality that actually culminates (and which would therefore be a reading event). However, I maintain that this inference of an occurrence of a reading event is pragmatic and not semantic, i.e., unless the hearer is told or has reason to believe otherwise, s/he is free to infer that there was a reading event and not merely a reading process.<sup>14</sup> Note that even if everyone knows that Irenka read the whole newspaper, it is still unacceptable to use the time-span adverbial with  $czyta^d$  in (3a).

The second argument is based on the following prediction: if  $czyta^d$  denotes the set of (non-culminated) reading processes, and  $prze-czyta^d$ , the set of (culminated) reading events, then it should be possible to negate any culmination when using the former verb but not when using the latter. The contrast in (4) shows that this prediction is borne out.

- (4)
- Irenka czytała<sup>1</sup> gazetę,      ale nie skończyła<sup>2</sup> jej  
Irenka read      newspaper.ACC but NEG finished      it.GEN  
czyta<sup>d</sup>.  
read
  - #Irenka read [at] the newspaper but she didn't finish reading it.  
#Irenka prze-czytała<sup>2</sup> gazetę, ale nie skończyła<sup>2</sup> jej czytać.  
#Irenka read the newspaper but she didn't finish reading it.'

The second clause of the sentences in (4) asserts that the reading eventuality lacks a culmination. In (4a), since  $czyta^d$  is analyzed as a predicate of processes and given that processes do not culminate, no contradiction results if a non-culmination is asserted. In (4b), however, since  $prze-czyta^d$  is analyzed as a predicate of events and given that events do culminate, a contradiction results if a non-culmination is asserted. Thus the contrast in (4) is readily explicable if the denotation of imperfective verbs is restricted to processes, and that of perfective verbs, to events.

This paper studies the relation of perfective verbs to imperfective and standard perfective verbs. In §2, I argue that perfective *po-* attaches to imperfective verbs denoting processes and entailing an Agent participant. In this respect, I believe that Polish *po-* shares its basic distribution with Russian *po-*, given Flier's (1985) observations about the latter. I provide an initial formulation of the conditions for *po-* prefixation that will provide the basis for later analysis. In §3, I show that five reliable tests for perfectivity in Polish indicate that perfective verbs pattern with perfectives and not imperfectives. In §4, I offer five arguments that perfective verbs are nevertheless like imperfectives (and unlike perfectives) in

<sup>14</sup>Holvoet (1991, fn. 4) makes a similar point about a different example.

that they denote processes and not events. Even so, they differ from imperfectives in asserting a bounded temporal interval of some kind. Pofective verbs are consequently like a cross between perfectives and imperfectives, exhibiting features of both. Finally, in §5, I present my analysis of pofective verbs. First, I introduce an algebraic part structure on the universe of discourse and argue for an analysis of *po-* as a *derived measure function* for processes. In essence, *po-* has the meaning of a durative adverbial with a contextual parameter. Second, I show that from this meaning assignment it follows that pofective predicates have *quantized reference*, which I maintain is the defining property of perfective predicates. In this way, I achieve a precise formulation of that property that pofectives have in common with standard perfective verbs, which has been a sticking point in previous analyses.

For example, Flier's (1985) claim that pofectives in Russian are actually achievement verbs can be rejected—a claim for which, as far as I can tell, there is also no compelling evidence. Nor is it necessary to appeal to an overly general notion of change that includes changes from one negative state to the same negative state, as Akimova 1992 claims for pofective verbs in Russian. The analysis that I will advocate dispenses with any direct reference to change. Finally, while Smith and Rappaport (1991, 302) make the intuitively correct claim that the pofective viewpoint in Russian “is defined to apply to situations with endpoints,” it is unclear how the addition of *po-* to an imperfective verb introduces the desired “arbitrary endpoints” (p. 321). In any case, the analysis that I will propose also avoids this puzzle by making no direct appeal to endpoints.

## 2 Pofectives

Pofective verbs are formed by prefixing *po-* to imperfective verbs. Nevertheless, *po-* cannot be prefixed to all imperfective verbs. Flier (1985, 46) states on the basis of Russian that pofectives “can be formed only from verbs denoting atelic activities,” which automatically rules out pofectives of stative, modal, accomplishment, and achievement verbs.<sup>15</sup> This generalization holds for Polish as well.<sup>16</sup>

<sup>15</sup>The terms ‘activity’, ‘accomplishment’, and ‘achievement’ are due to Vendler 1957. Note that I equate processes with activities, and events with accomplishments and achievements, assuming that Vendler's terms refer to entities in the universe of discourse.

<sup>16</sup>If I am correct, all event-denoting verbs are perfective, hence the restriction to imperfective verbs would rule out pofectives of accomplishment and achievement verbs. Also, Kipka (1990, 31) notes that Polish perfective verbs in general do not allow more than one prefix.

- (5) a. *писа́ть* ‘write’ / *по-писа́ть* ‘write for a while’  
       *је́сть* ‘eat’ / *по-је́сть* ‘eat for a while’  
       *пра́цова́ть* ‘work’ / *по-пра́цова́ть* ‘work for a while’  
       *сиде́ть* ‘sit’ / *по-сиде́ть* ‘sit for a while’  
       *ле́жать* ‘lie’ / *по-ле́жать* ‘lie for a while’  
       *бы́ть* ‘be’ / *по-бы́ть* ‘be for a while’  
       *мие́ть* ‘have’ / \**по-мие́ть*  
       *мо́чь* ‘be able’ / \**по-мо́чь*  
       *прече́зывать* ‘read’ / \**по-прече́зывать*

Whereas the pofectives in (5a) are derived from verbs that unambiguously denote processes, this is not so for the pofectives in (5b). In fact, one might argue that the imperfectives in (5b) denote only states and therefore conclude that *po-* applies to both process and stative verbs.<sup>17</sup> But this is not correct: in addition to *мие́ть* ‘have’ in (5c), other stative verbs like *любие́* ‘like’ (\**по-любие́*) and *зна́ть* ‘know’ (\**по-зна́ть*) do not have pofective forms, hence *po-* would mysteriously not apply to many stative verbs. Moreover, the following contrast—inspired by Flier's (19)—suggests that verbs like *ле́жать* ‘lie’ are ambiguous between process and stative readings, depending on whether the subject argument is animate or not.

- (6) a. *Дите́чко по-ле́жало на столе́.*  
       child lay on table.LOC  
       ‘The child lay on the table for a while.’  
       b. *#Кни́жка по-ле́жала на столе́.*  
       ‘The book lay on the table for a while.’

Flier (p. 55) comments that situations described by pofectives require a “controlling force,” which is “the crucial factor in the initiation and termination of activities.” As inanimate objects do not exercise such control, (6b) is unacceptable. Animate objects, in contrast, do exercise this control, and so (6a) is fine.

A parallel contrast is observed with the pofective of *бы́ть* ‘be’: (7a) is unacceptable because books have no control over how long they are at a person's house, but (7b) is fine precisely because people do have such control.

- (7) a. *#Мое́я кни́жка по-бы́ла вче́рзай у Иренки́.*  
       my book was yesterday at Irenka.GEN  
       ‘My book was at Irenka's place for a while yesterday.’  
       b. *Бо́жана по-бы́ла вче́рзай у Иренки́.*

<sup>17</sup>Flier does not discuss the Russian equivalent of *бы́ть* ‘be’ / *по-бы́ть*.

'Bożena was at Irenka's place for a while yesterday.'

To cast the issue more concretely, let us say that any Agent participant in a process (potentially) controls the initiation and termination of that process—this is partly what it means to be an Agent. Minimally, then, the following complex condition holds for pfective formation:

- (8) Pfective *po-* applies to any imperfective verb that  
 (a) denotes a property of processes and  
 (b) entails an Agent participant.

The verbs in (5b) differ from those in (5a) in admitting a stative reading in addition to a process reading. As claimed in §1, stative predicates denote properties of times. This means that the verbs in (5b) can be predicated of either times or processes. Furthermore, if we reconstruct thematic roles like Agent as relations between eventualities and object participants, then we should say that verbs like those in (5b) entail an Agent participant if they are predicated of processes. These facts are guaranteed by the following meaning postulates:<sup>18</sup>

- (9) For all  $\Delta$  in {siedzieć', leżeć', być', ...} (cf. (5b)):  
 a.  $\forall x[\Delta(x) \rightarrow x \in T \vee x \in P]$   
    ( $\Delta$  applies to times or processes)  
 b.  $\forall p[\Delta(p) \rightarrow \exists u[Agent(u)(p)]]$   
    ( $\Delta$  as a process predicate entails an Agent)

(9a) states that the imperfective predicates in the given set denote a property of either times or processes. (9b) guarantees that if the chosen predicate denotes a property of processes, then it entails the existence of an Agent participant.

The Agent relation invoked in (9b) is not entailed by all eventualities (e.g., *The leaf fell silently*). Furthermore, it should not be entailed by states at all. To make this explicit, I propose that the Agent relation be restricted to eventualities proper. Since states are reconstructed as properties of times, this means that Agents are never directly related to temporal intervals, which seems intuitively correct. Since this pattern no doubt holds for some other thematic relations as well, e.g., Patient, I assume that the following postulate is true for the relevant set of thematic relations.<sup>19</sup>

- (10) For all  $\Delta$  in {Agent, Patient, ...}:  
 $\forall x \exists u[\Delta(u)(x) \rightarrow x \in V]$  ( $\Delta$  applies to eventualities only)

<sup>18</sup> A word about variables:  $x$  is unsorted, and  $u$  is sorted for O, the set of objects.

<sup>19</sup> A thematic relation like Theme might be defined for times.

Unfortunately, although the condition on pfective formation given in (8) is necessary, it is not sufficient. In particular, there are imperfective agentive process verbs that do not have corresponding pfective forms. One such exception is the contrast between the two imperfective process verbs *biegnąć* 'run' (\**po-biegnąć*) and *biegać* 'run' (*po-biegać*), which are very close in meaning. Roughly, the difference is that whereas *biegnąć* is used to assert a one-way trip of running to some goal, *biegać* can be used to describe running in the absence of a goal. This exception is not isolated; it follows a general pattern for verbs of motion in Polish. However, as an analysis of verbs of motion is beyond the scope of this paper, I keep (8) as a working hypothesis, even if another restriction is at work. In the next two sections, I discuss the properties of pfective verbs once they are formed.

### 3 Pfectives as perfectives

Pfective verbs pattern with perfective and not imperfective verbs according to five pieces of evidence. To one who knows Polish, this clustering of pfectives with perfectives may be intuitively obvious, as there are excellent diagnostics for (im)perfectivity in Polish. However, I find it instructive to present the arguments in support of this claim, because they offer insight into the semantic analysis of (im)perfectivity, which is a prerequisite for understanding pfective verbs. Furthermore, I am not aware of any work that details this claim explicitly.

**Argument 3.1.** Imperfective verbs, but not perfective verbs, can refer to the speech time in the non-past tense conjugation. Pfective verbs pattern like perfective verbs in this regard.

- (11) a. Bożena czyta gazetę.  
       Bożena reads newspaper.ACC  
       'Bożena is reading the newspaper.'  
       b. Bożena prze-czyta gazetę.  
       Bożena prze-reads newspaper.ACC  
       'Bożena will read the newspaper.'  
       c. #Bożena is reading the newspaper.'  
       Bożena po-czyta gazetę.  
       'Bożena will read the newspaper for a while.'  
       #Bożena is reading the newspaper for a while.'

**Argument 3.2.** Imperfective verbs, but not perfective verbs, can occur as non-finite complements of aspectualizing verbs such as the future auxiliary *być* 'be',

*za-cząć*<sup>P</sup> 'begin', *prze-stać*<sup>P</sup> 'stop', and *s-kończyć*<sup>P</sup> 'finish'. Pofective verbs also cannot appear in these environments.

- (12) a. Irenka będzie<sup>1</sup> piła<sup>1</sup> mleko.  
Irenka will drink milk.ACC  
'Irenka will drink milk.'  
b. \*Irenka będzie<sup>1</sup> wy-piła<sup>P</sup> mleko.  
Irenka will wy-drink milk.ACC  
c. \*Irenka będzie<sup>1</sup> po-piła mleka / mleko.  
Irenka will po-drink milk.GEN milk.ACC  
'Irenka will drink (some) milk.'
- (13) a. Irenka nagle prze-stała<sup>P</sup> pić<sup>1</sup> mleko.  
Irenka suddenly stopped drink milk.ACC  
'Irenka suddenly stopped drinking the milk.'  
b. \*Irenka nagle prze-stała<sup>P</sup> wy-pić<sup>P</sup> mleko.  
Irenka suddenly stopped wy-drink milk.ACC  
c. \*Irenka nagle prze-stała<sup>P</sup> po-pić mleka / mleko.

**Argument 3.3.** Whereas imperfective verbs admit a progressive reading in the past tense, neither perfective verbs nor pofective verbs do. This can be shown by whether the two eventualities related by the temporal connective *kiedy* 'when' are interpreted as overlapping or sequential in time.

- (14) a. Kiedy Kasia jadła<sup>1</sup> świeży chleb, Piotr wróciła<sup>P</sup>.  
when Kasia ate fresh.ACC bread.ACC Peter returned  
'When Kasia was eating fresh bread, Peter returned.'  
b. Kiedy Kasia zjadła<sup>P</sup> świeży chleb, Piotr wróciła<sup>P</sup>.  
when Kasia z-ate fresh.ACC bread.ACC Peter returned  
'When Kasia ate / had eaten the fresh bread, Peter returned.'  
# 'When Kasia was eating fresh bread, Peter returned.'  
c. Kiedy Kasia po-jadła świeżego chleba / świeży  
when Kasia po-ate fresh.GEN bread.GEN fresh.ACC  
chleb, Piotr wróciła<sup>P</sup>.  
'When Kasia ate / had eaten [of] the fresh bread for a while, Peter returned.'  
# 'When Kasia was eating fresh bread for a while, Peter returned.'

**Argument 3.4.** Polish has two types of adverbial participles: the 'present participle' [*imiestów przystówkowy współczesny*] and the 'perfect participle' [*imiestów przystówkowy uprzedni*]. Of these two participles, imperfective verbs have only present participles (*-ąc* forms), and perfective verbs have only perfect

participles (*-(w/t)szy* forms). Pofective verbs, like perfective verbs, have only perfect participles.

- (15) a. czytając<sup>1</sup> 'reading' \*czytawszy<sup>1</sup> 'having read'  
b. pijąc<sup>1</sup> 'drinking' \*piwszy<sup>1</sup> 'having drunk'  
c. jedząc<sup>1</sup> 'eating' \*jadłszy<sup>1</sup> 'having eaten'  
d. \*prze-czytając<sup>P</sup> prze-czytawszy<sup>P</sup> 'having read'  
e. \*wy-pijąc<sup>P</sup> wy-piwszy<sup>P</sup> 'having drunk'  
f. \*z-jedząc<sup>P</sup> z-jadłszy<sup>P</sup> 'having eaten'  
g. \*po-czytając po-czytawszy 'having read for a while'  
h. \*po-pijąc po-piwszy 'having drunk for a while'  
i. \*po-jedząc po-jadłszy 'having eaten for a while'
- (16) a. Cztając<sup>1</sup> gazetę, Bożena słuchała<sup>1</sup> muzyki.  
reading newspaper.ACC Bożena listened music.GEN  
'Reading the newspaper, Bożena listened to music.'  
b. Prze-czytawszy<sup>P</sup> gazetę, Bożena wy-szła<sup>P</sup>  
having read newspaper.ACC Bożena wy-went  
z czytelnii.  
out of reading room.GEN  
'Having read the newspaper, Bożena left the reading room.'  
c. Po-czytawszy gazetę, Bożena wy-szła<sup>P</sup> z czytelnii.  
'Having read the newspaper for a while, Bożena left the reading room.'

**Argument 3.5.** Polish has two verbal passive constructions, the *zostać*<sup>P</sup> passive and the *być*<sup>1</sup> passive. In the *zostać*<sup>P</sup> passive, the 'passive participle' [*imiestów przymiotnikowy bierny*] must be perfective, and in the *być*<sup>1</sup> passive, it must be imperfective. While pofectives are possible (though rare) in the *zostać*<sup>P</sup> passive, they are clearly unacceptable in the *być*<sup>1</sup> passive.

- (17) a. \*Świeży chleb został<sup>P</sup> jedzony<sup>1</sup>.  
fresh bread became eaten  
'The fresh bread was eaten.'  
b. Świeży chleb został<sup>P</sup> zjedzony<sup>P</sup>.  
fresh bread became z-eaten  
'The fresh bread was eaten.'  
c. Świeży chleb został<sup>P</sup> po-jedzony (przez chwilę).  
fresh bread became po-eaten through while.ACC  
'The fresh bread was eaten (for a while).'

- (18) a. \*Książka została<sup>P</sup> czytana<sup>I</sup>.  
book became read  
'The book was read.'  
b. Książka została<sup>P</sup> prze-czytana<sup>P</sup>.  
book became *prze-read*  
'The book was read.'  
c. Książka została<sup>P</sup> po-czytana (przez chwilę).  
'The book was read (for a while).'

The next examples show that both perfectives and pfectives are ungrammatical in the *by*<sup>I</sup> verbal passive:

- (19) a. Świeży chleb był<sup>I</sup> jedzony<sup>I</sup> przez Irenkę.  
'The fresh bread was eaten by Irenka.'  
b. \*Świeży chleb był<sup>I</sup> z-jedzony<sup>P</sup> przez Irenkę.  
c. \*Świeży chleb był<sup>I</sup> po-jedzony przez Irenkę.

In sum, evidence from present temporal reference, auxiliary aspectualizers, progressivity, adverbial participle formation, and two types of verbal passives all argue that pfective verbs pattern with perfective and not imperfective verbs. Consequently, whatever the defining property that standard perfectives have, pfectives also appear to have.

#### 4 Pfectives despite perfectives

Although pfective verbs share a salient property with perfectives, five other pieces of evidence show that the parallel between pfectives and perfectives breaks down in certain contexts. I offer the following five arguments in support of the claim that pfectives also have a salient property in common with imperfectives.

**Argument 4.1.** Pfectives are always compatible with durative adverbials and never with time-span adverbials. Recalling the discussion of (3) in §1, this means that pfective verbs, like non-stative imperfective verbs, denote processes and not events.

- (20) a. Bożena czytała<sup>I</sup> gazetę dwadzieścia minut.  
Bożena read newspaper.ACC twenty.ACC minutes.GEN  
'Bożena read the newspaper for twenty minutes.'  
b. #Bożena prze-czytała<sup>P</sup> gazetę dwadzieścia minut.  
c. Bożena po-czytała gazetę dwadzieścia minut.  
'Bożena read the newspaper for twenty minutes.'

- (21) a. #Bożena czytała<sup>I</sup> gazetę w dwadzieścia minut.  
Bożena read newspaper.ACC in twenty.ACC minutes.GEN  
b. Bożena prze-czytała<sup>P</sup> gazetę w dwadzieścia minut.  
'Bożena read the newspaper in twenty minutes.'  
c. #Bożena po-czytała gazetę w dwadzieścia minut.

Another version of this argument is based on how the ambiguous temporal preposition *do* 'until; by' is interpreted with such verbs. Whereas only the 'until' reading is acceptable with imperfectives and pfectives, only the 'by' reading is acceptable with perfectives.

- (22) a. Kasia czytała<sup>I</sup> książkę do (białego) rana.  
Kasia read book.ACC until white.GEN morning.GEN  
'Kasia read the book until early dawn.'  
#Kasia read the book by early dawn.  
b. #Kasia prze-czytała<sup>P</sup> książkę do (białego) rana.  
Kasia *prze-read* book.ACC until white.GEN morning.GEN  
#Kasia read the book until early dawn.  
#Kasia read the book by early dawn.  
c. Kasia po-czytała książkę do (białego) rana.  
Kasia *po-read* book.ACC until white.GEN morning.GEN  
'Kasia read the book until early dawn.'  
#Kasia read the book by early dawn.'

**Argument 4.2.** The VP modifier *prawie* 'almost' is acceptable with perfectives, but not with imperfectives or pfectives. Evidently, Polish *prawie* modifies event-denoting predicates and not process-denoting ones.

- (23) a. \*Irenka prawie czytała<sup>I</sup> gazetę.  
Irenka almost read newspaper.ACC  
'Irenka almost read the newspaper.'  
b. Irenka prawie prze-czytała<sup>P</sup> gazetę.  
'Irenka almost read the newspaper.'  
c. \*Irenka prawie po-czytała gazetę.  
(24) a. \*Bożena prawie piła<sup>I</sup> mleko.  
Bożena almost drank milk.ACC  
'Bożena almost drank milk.'  
b. Bożena prawie wy-piła<sup>P</sup> mleko.  
'Bożena almost drank up the milk.'  
c. \*Bożena prawie po-piła mleka / mleko.  
'Bożena almost drank [some] milk.'

(cf. (12c))

**Argument 4.3.** Pofectives do not always behave like imperfectives, however, even if we restrict our attention to contexts with durative adverbials, where both occur (and where standard perfectives do not occur). In particular, it is possible to assert an unexpected continuation of an imperfective process, but not of a pofective process. This suggests that pofectives introduce a bounded interval of some kind, whereas imperfectives do not.

- (25) a. Kasia czytała gazetę jedną godzinę, a potem  
Kasia read newspaper.ACC one.ACC hour.ACC and then  
dalej czytała.  
further read  
'Kasia read the newspaper for one hour and then she read [it]  
further.'  
b. #Kasia po-czytała gazetę jedną godzinę, a  
Kasia po-read newspaper.ACC one.ACC hour.ACC and  
potem dalej po-czytała.  
then further po-read  
'Kasia read the newspaper for one hour and then she read [it]  
further.'

**Argument 4.4.** The *być* passive illustrated in (19) can also be interpreted as an adjectival passive, provided that the *przez*-phrase is absent. Both imperfectives and perfectives appear in the adjectival passive construction, but pofectives do not. This can be accounted for if pofectives denote processes that are already temporally measured.

- (26) a. Mleko jest pite.  
milk is drunk  
'The milk is drunk.'  
b. Mleko jest wy-pite.  
'The milk is drunk (up).'  
c. #Mleko jest po-pite.  
'The milk is drunk for a while.'  
(the English sentence also excludes an adjectival passive  
interpretation)

- (27) a. Książka jest czytana.  
book was read  
'The book is read.'  
b. Książka jest prze-czytana.  
'The book is (completely) read.'  
c. #Książka jest po-czytana.

'The book is read for a while.'

**Argument 4.5.** Certain D°-quantifiers lacking an overt NP complement and adverbial quantifiers co-occurring with a missing direct object exhibit a potential ambiguity between a nominal and temporal quantificational interpretation. Interestingly, only the nominal quantificational interpretation is available with perfectives, and only the temporal quantificational interpretation is acceptable with imperfectives and pofectives.<sup>20</sup>

- (28) a. Irenka czytała trochę.  
Irenka read a little.ACC  
'Irenka read a little.'  
(i.e., for a short time: *trochę* as a temporal quantifier)  
b. Irenka prze-czytała trochę.  
'Irenka read a little.'  
(i.e., a small amount of material: *trochę* as a nominal quantifier)  
c. Irenka po-czytała trochę.  
'Irenka read a little.'  
(i.e., for a short time: *trochę* as a temporal quantifier)
- (29) a. Ile Bożena już czytała?  
how much.ACC Bożena already read  
'How much [time] did Bożena already read?'  
(*ile* as a temporal quantifier)  
b. Ile Bożena już prze-czytała?  
'How much [material] did Bożena already read?'  
(*ile* as a nominal quantifier)  
c. Ile Bożena już po-czytała?  
'How much [time] did Bożena already read?'  
(*ile* as temporal quantifier)
- (30) a. Kasia pisała krótko.  
Kasia wrote shortly  
'Kasia wrote for a short time.'

<sup>20</sup> At any rate, the temporal quantificational reading is by far the dominant one with imperfectives and pofectives. It appears that there is a marginal nominal quantificational reading when the Patient participant is less concrete or tangible, e.g.: *Irenka (po-)czytała trochę (angielskiego)* 'Irenka read a little (English)', cf. (28a,c). The question of concreteness is a difficult matter, so I put it gracefully aside. The crucial point is that the temporal quantificational reading is clearly dominant with imperfectives and pofectives and unacceptable with perfectives.

- b. Kasia na-pisała<sup>P</sup> krótko.  
Kasia *na*-wrote shortly  
'Kasia wrote a short amount.'  
c. Kasia po-pisała krótko.  
'Kasia wrote for a short time.'

In sum, evidence from durative and time-span adverbials, modification with *prawie* 'almost', the possibility of asserting immediate continuation with *dalej* 'further', the *był*<sup>21</sup> adjectival passive, and the interpretation of D<sup>o</sup>-quantifiers and adverbial quantifiers all suggest that perfectives, like imperfectives, denote processes, but unlike the processes denoted by imperfectives, these processes are essentially temporally bound. Evidently, it is this quality of temporal boundedness that makes perfectives pattern like perfectives, an intuition shared by all those that have studied the problem. In the next and final section, I present a semantic analysis that aims to capture this intuition formally.

## 5 Analysis

Any analysis of perfectivity should account for the fact that perfectives at once denote processes (like non-stative imperfectives and unlike standard perfectives) and yet behave like perfectives with respect to many criteria (unlike imperfectives). Accordingly, my proposal is twofold: the first part concerning the relation of perfective verbs to imperfectives, and the second, about their relation to perfectives. I summarize my claims as follows:

- Perfective *po*- restricts the denotation of imperfective process predicates to those processes that last shorter than some contextually expected length of time. Thus *po*- has the core meaning of a durative adverbial. Formally, I analyze *po*- as a *derived measure function* for processes.
- Formally, standard perfective predicates have the defining property of *quantized reference*. Although most perfective verbs denote events, perfectives do not, hence perfectivity cannot be defined in terms of event-denoting predicates. However, the analysis of *po*- as a measure function automatically yields the result that perfective predicates, like standard perfective predicates and in contrast to imperfective predicates, have quantized reference.

To show how this proposal works, I proceed in three steps. In §5.1, I present the idea that the universe of discourse is structured algebraically as a part-theoretic partial ordering. This enables us to refer to parts of processes, for example. Then, in §5.2, with the structured universe in place, I demonstrate how it can be used in the analysis of perfective verbs. Finally, in §5.3, I indicate how

the data examined in §§3–4 are sensitive to the denotations and reference properties of verbal predicates.

### 5.1 Structuring the universe of discourse

Recall from §1 that the universe of discourse which I assume includes objects, times, real numbers, and eventualities, designated by the sets  $O, T, R, V$  ( $= P \cup E$ ), respectively. In any given set, various entities stand in certain relations to others, e.g., in  $P$  a smaller reading process may be 'contained' within a larger reading process. Since entities are themselves not sets, this 'containment' relation cannot be straightforwardly modelled by set-theoretic inclusion—we need a notion of *part*. Instead of taking *part* as primitive, however, let us define it in terms of a primitive operation *join* ( $\oplus$ ) on the sets  $O, T, V$  in the universe of discourse.<sup>21</sup> Specifically, we want to take any two entities from one of these sets and join them to create a more complex entity. Note that the created entity, although complex, should still be an entity and not a set of entities. For example, suppose that we take two reading processes  $p_1, p_2$  from  $P$ : their join is  $p_1 \oplus p_2$ , the smallest reading process constructed from  $p_1$  and  $p_2$ . In general, join is an operation that takes two (not necessarily simple) entities and yields a third (more complex) one. Note that since the sets  $O, T, V$  are postulated to be disjoint (cf. §1), it makes no sense to have join apply to entities of different sorts. The following axiom therefore explicitly restricts join to entities of the same sort:

$$(31) \quad \forall x \forall y \exists z [x \oplus y = z \rightarrow x, y \in O \vee x, y \in T \vee x, y \in P \vee x, y \in E]$$

( $\oplus$  applies to entities of the same sort)

The join operation has other properties that we want to guarantee. First, it is *closed* with respect to the sets it is defined for. This means that the join of any two entities in the chosen set is again an entity of that set. Second, the join of an entity with itself yields the same entity (*idempotency*). Third, the join of two entities is indifferent to order of join (*commutativity*). Fourth and finally, we can apply join pairwise to three or more entities in any order (*associativity*). These axioms are formalized in (32).

$$(32) \quad \begin{array}{ll} \text{a. } \forall x \forall y \exists z [x \oplus y = z] & (\text{closure}) \\ \text{b. } \forall x [x \oplus x = x] & (\text{idempotency}) \\ \text{c. } \forall x \forall y [x \oplus y = y \oplus x] & (\text{commutativity}) \\ \text{d. } \forall x \forall y \forall z [x \oplus (y \oplus z) = (x \oplus y) \oplus z] & (\text{associativity}) \end{array}$$

<sup>21</sup>Join is not defined for  $R$ , the set of real numbers. This is discussed below.

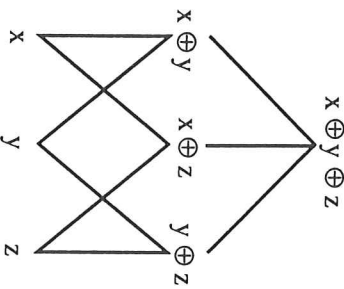
For example, by (32a) the join of two reading processes is again a reading process. By (32b), the join of a reading process with itself is simply the same reading process—we do not count the same entity twice. And by (32c–d), we can join two or more reading processes in any order. Although this may initially seem unintuitive, note that join does not specify temporal precedence, hence the complex process  $p_1 \oplus p_2$  does not entail that  $p_1$  temporally precedes  $p_2$ : the question of temporal realization is simply left open.

It is now possible to define the desired part relations in terms of join. Intuitively, the process  $p_1$  is part of the complex process  $p_1 \oplus p_2$  iff the join of  $p_1$  with  $p_1 \oplus p_2$  is again  $p_1 \oplus p_2$ . Using associativity and idempotency from (32), this clearly holds for the example at hand (i.e.,  $p_1 \oplus (p_1 \oplus p_2) = (p_1 \oplus p_1) \oplus p_2 = p_1 \oplus p_2$ ). The general part-of relation allows equality as a limiting case; the proper part relation stipulates inequality. Finally, it is evident that the two complex processes  $p_1 \oplus p_2$  and  $p_2 \oplus p_3$  overlap precisely because  $p_2$  is part of both. The formal definitions follow:

- (33)    a.  $\forall x \forall y [x \leq y \leftrightarrow x \oplus y = y]$  (part)  
           b.  $\forall x \forall y [x < y \leftrightarrow x \leq y \wedge \neg x = y]$  (proper part)  
           c.  $\forall x \forall y [x \circ y \leftrightarrow \exists z [z \leq x \wedge z \leq y]]$  (overlap)

The part relations make explicit the partial ordering among entities already immanent in the complex entities created by join. If the set is finite (and I assume that the sets in question are), these relations can be depicted graphically in the form of a *Hasse diagram*. For the sake of illustration, suppose that the chosen set has three non-overlapping entities (e.g., three basic reading processes) to which join freely applies (guaranteed by closure in (32a)). The algebraic structure of this set is depicted in (34). Each node stands for an entity: entities that are vertically lower are connected by lines to ones higher iff the former are proper parts of the latter. Two entities overlap iff they are connected to the same lower entity by a line.

(34)

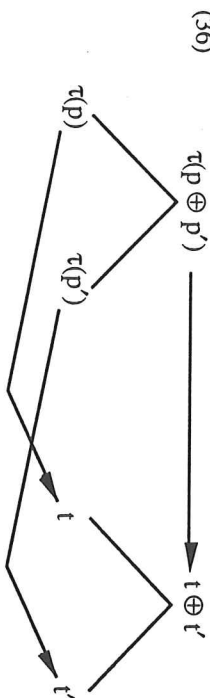


Note that (34) exemplifies the unsorted structure of any of the sets  $O$ ,  $T$ ,  $P$ ,  $E$ . We now want to set up correspondences between sorts. For example, eventualities take place in time, and yet nothing said so far relates them to times. The *temporal trace* function  $\tau$  is defined for this purpose. It maps eventualities

into their temporal realizations, respecting the part structure created by join.<sup>22</sup>

- (35)     $\tau: P \cup E (= V) \rightarrow T$   
           ( $\tau$  maps from eventualities to times)  
            $\forall v \forall v' [\tau(v \oplus v') = \tau(v) \oplus \tau(v')]$   
           ( $\tau$  respects  $\oplus$ )

To say that  $\tau$  respects the structure created by join means that the result of applying  $\tau$  to the join of two eventualities is the same as applying  $\tau$  first to each of the two eventualities independently and then joining the two times. This is depicted in (36) for the join of two processes; the generalization to more complex structures like that in (34) is clear.



Recall from (31) that join does not operate on  $R$ , the set of real numbers. This is intuitively correct, for although the real numbers are doubtlessly ordered, they are not ordered by the part relations. Thus, while the number 2 is less than the number 5, it does not seem correct to say that 2 is a proper part of 5. In place of join, I assume the four standard arithmetical operations, viz., addition (+), subtraction (−), multiplication (•), and division (÷). Like join, these operations apply to two entities and yield a third one. Since they are familiar, I forego the axiomatization of their properties. The partial ordering among the numbers created by these operations is made explicit by the relations less-than ( $<$ ), less-than-or-equal-to ( $\leq$ ), greater-than ( $>$ ), and greater-than-or-equal-to ( $\geq$ ). Restricting our attention to the subset of positive real numbers ( $R^+$ ), the first two of these relations may be defined in terms of addition as follows:

- (37)    For all  $r, r' \in R^+$ :  
           a.  $\forall r \forall r' [r \leq r' \leftrightarrow \exists r'' [r'' \in R^+ \cup \{0\} \wedge r + r'' = r']]$  (less-than-or-equal-to)  
           b.  $\forall r \forall r' [r < r' \leftrightarrow r \leq r' \wedge \neg r = r']$  (less-than)

<sup>22</sup> I adapt my formulation of the temporal trace function from Krifka (1989b, 97), who, however, does not distinguish between processes and events. Technically,  $\tau$  is homomorphic with respect to join. Note that  $v, v'$  are sorted variables for eventualities.

To paraphrase, two positive real numbers  $r, r'$  stand in the less-than relation iff there is a positive real number such that the result of adding it to  $r$  is equal to  $r'$ .

Just as we set up a correspondence between the sorts of eventualities and times in (35) (eventualities take place in time), we now want to set up a correspondence between the sorts of times and (positive) real numbers (times have a certain duration). This latter correspondence, however, is not as straightforward precisely because there is no operation common to both T and R. For example, just as times are not added, real numbers are not joined, hence times do not stand in the less-than-or-equal-to relation to each other, and real numbers do not stand in the part-of relation to each other. What we need is a function that preserves the empirical relation part-of for times in the arithmetical relation less-than-or-equal-to for real numbers. The functions that achieve this are *measure functions*  $\mu$  for times. Since times may be measured in hours, minutes, seconds, etc., there is no unique measure function for times, hence  $\mu$  is a variable over such measure functions. Moreover,  $\mu$  is an additive measure function for times iff it preserves the join of (non-overlapping) times in the addition of real numbers.

(38)

$$\mu: T \rightarrow R^+$$

( $\mu$  maps from times to positive real numbers)

$$a. \quad V\mu[\text{MFT}(\underline{\ell}, \mu) \leftrightarrow VtVt'[t \underline{\ell} t' \rightarrow \mu(t) \leq \mu(t')]]$$

( $\mu$  is a measure function on  $T$  with respect to  $\preceq$ )

b.  $\forall \mu[\text{AMFT}(\oplus, \angle, \mu) \leftrightarrow$

$$\text{MFT}(\underline{\mathbb{Z}}, \mu) \wedge \forall t \forall t' [\neg t \circ t' \rightarrow \mu(t) + \mu(t') = \mu(t \oplus t')]$$

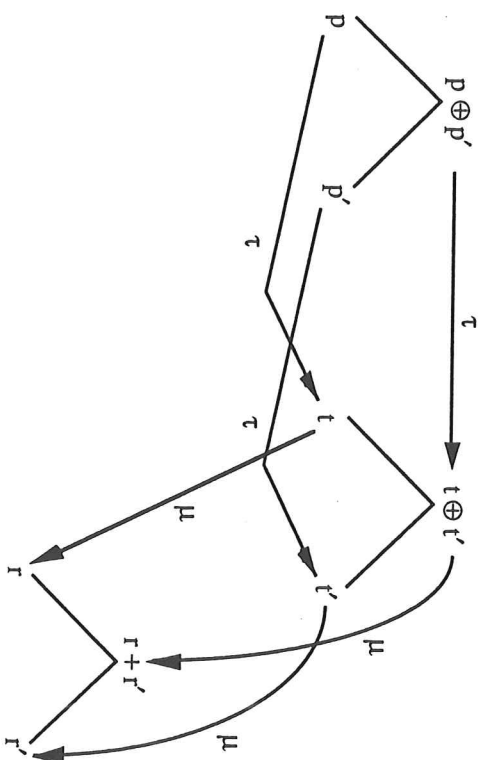
( $\mu$  is an additive measure function on  $\mathbf{T}$  with respect to  $\oplus$  and  $\angle$ )

(38) states that the qualifying measure functions  $\mu$  apply to times and yield positive real numbers as values. The restriction to positive reals models the fact that all times have duration—there is no time (whether an instant or an interval) without at least some duration. (38a) defines  $\mu$  as preserving the part-of relation on times in the less-than-or-equal-to relation on positive real numbers. Consequently, if interval  $t$  is a proper part of interval  $t'$ , then the duration of  $t$  is less than the duration of  $t'$ , which is the correct result. Finally, (38b) states that  $\mu$  is additive iff it preserves the join of two non-overlapping times in the addition of real numbers. Note that the times should not overlap, for otherwise  $\mu$  would measure their common part twice. For example, suppose that Irenka reads for twenty minutes and that this reading process is the join of two (simpler) reading processes. Assume further that the latter two do not overlap and have temporal traces of equal duration (i.e., ten minutes each): it is evident that the sum of their durations is twenty minutes. Suppose now that the two reading processes overlap, such that duration of the first is fifteen minutes and of the second, ten minutes, with a five minute overlap. The sum of their durations is now twenty-

five minutes, which contradicts the fact that Irenka read for only twenty minutes. Hence it is necessary to disregard overlapping times when measuring them with respect to join, as (38b) requires.

To summarize, we have postulated a join operation for the sets  $O$ ,  $T$ ,  $V$  in the universe of discourse, whose partial orderings are defined by the part relations. The set  $R$  differs from these in that it is structured by the standard arithmetical operations and ordered by the less-than-or-equal-to relation. Since these sets are disjoint, mappings are needed to define correspondences between them. We defined two such mappings, the temporal trace function  $\tau$  that maps eventualities into their temporal realization, and an additive measure function  $\mu$  that maps times into positive real numbers. The diagram in (39) shows how these functions relate to each other in determining how long a complex process (e.g., a reading) lasts.

(39)



First,  $\tau$  is applied to the reading process, mapping it into its temporal trace, preserving its part structure. Then, an additive measure function for times is chosen, which measures the duration of the temporal trace, preserving its part-theoretic ordering in the arithmetical ordering less-than-or-equal-to.

In closing this section, the model that I assume is  $\mathbb{M} = \langle \langle \mathcal{O}, \mathcal{T}, \mathcal{P} \cup \mathcal{E}, \oplus, \leq, \angle, \circ \rangle, \langle \mathcal{R}, +, -, \bullet, \div, <, \leq, >, \geq \rangle, [\mathbb{I}, \mathbb{J}] \rangle$ . I have discussed only those details of  $\mathbb{M}$  that are prerequisites for my analysis of the pofective in the next section. In the larger scheme of things, we would also require notions of temporal precedence and convexity defined on times, as well as mappings between objects and

eventualities. But as these are less central to the analysis of the pfective, I do not discuss them in this paper.

## 5.2 *po-* as a derived measure function

As mentioned at the outset of §5, my guiding intuition is that pfective *po-* has the basic meaning of a durative adverbial. However, unlike standard durative adverbials (e.g., *for twenty minutes*), the meaning of *po-* does not specify a duration value. Instead, it allows this value to be determined by the context of utterance. Consider my proposed lexical entry for *po-*:

$$(40) \quad po-, [V^o \text{ — } [V^o \alpha]] \\ po- \Rightarrow \lambda Q \lambda p [Q(p) \wedge \mu(\tau(p)) = r \wedge r < \text{Exp}(\mu(\tau(p))) \wedge \exists u [\text{Agent}(u)(p)]] \\ \text{(type } \langle \langle e, t \rangle, \langle e, t \rangle \rangle \text{)}$$

[Bound variables:  $Q$ , for predicates of type  $\langle e, t \rangle$ ;  $p$  for processes;  $\mu$  for objects. Free variables:  $\mu$ , a contextually determined additive measure function;  $r$ , a contextually determined small number.  $\text{Exp}(\mu(\tau(p)))$  is the expectation value of  $\mu$  as applied to the temporal trace of  $p$ .]

The first line of (40) gives the necessary morphosyntactic information for *po-*, viz., it attaches to  $V^o$ s to create  $V^o$ s. Given that  $V^o$ s are analyzed as one-place predicates of times or eventualities in the event semantics that I am adopting (cf. §1), it follows that *po-* should be semantically analyzed as a modifier, i.e., as a function that applies to one-place predicates of eventualities to yield one-place predicates of eventualities. Thus its semantic type is  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$ , as stated in the third line of (40). The second line of (40) gives the semantic translation of *po-*. Let me explain each conjunct of the translation in turn.

First, the formula translating *po-* is sortally restricted to apply to process predicates; this captures the condition informally stated in (8a). Second, it entails a measure function  $\mu$ , whose value when applied to the temporal trace of the process in question is  $r$ . Note that the meaning of *po-* does not specify the value of  $\mu$ , on which the value of  $r$  is dependent—these are left as free variables, to be assigned implicit values by the context of use. Third, it asserts that the value assigned to  $r$  is less than the *expectation value* of  $\mu$  as applied to the temporal trace of  $p$ , which takes its value from the positive real numbers. This duration expectation value varies with the context, the value of  $p$  is never the same from context to context. Intuitively, the value assigned to  $\text{Exp}(\mu(\tau(p)))$  is determined by how long the speaker expects the process in question to last. Fourth and finally, the last conjunct asserts that all processes (in the denotation of a predicate  $Q$ ) to which  $[[po-]]^{M,g}$  applies have an Agent participant. If, at the point of evaluating the truth of the clause containing the pfective verb, no DP denotes an Agent participant of the process described, then there is no Agent for the process and

the proposition expressed by this conjunct (and consequently, the clause) will be false. Note that this conjunct captures the condition given in (8b).<sup>23</sup>

Technically,  $\mu$  should be a *derived measure function* for processes. Its domain is not times in general, but rather those times that are temporal traces of processes. In other words, we want to measure processes, but we can do so only indirectly, by measuring their temporal traces. I therefore define  $\mu'$  as a derived measure function for processes in terms of  $\mu$ , a measure function for times, as in (41a). The translation of *po-* in (40) can then be reformulated accordingly, as in (41b).

$$(41) \quad \text{a. } \forall p [\mu'(p) = \mu(\tau(p))] \quad (\mu' \text{ is a derived measure function}) \\ \text{b. } po- \Rightarrow \lambda Q \lambda p [Q(p) \wedge \mu'(p) = r \wedge r < \text{Exp}(\mu'(p)) \wedge \exists u [\text{Agent}(u)(p)]]$$

Consider how my treatment of *po-* works for *po-czytać* in (1c). The function denoted by *po-* applies to the predicate translating *czytać* 'read'. This is shown in (42).

$$(42) \quad po-czytać \Rightarrow \lambda Q \lambda p [Q(p) \wedge \mu'(p) = r \wedge \\ r < \text{Exp}(\mu'(p)) \wedge \exists u [\text{Agent}(u)(p)]] [\lambda p [\text{czytać}(p)]] \Rightarrow \\ \lambda p [\text{czytać}(p) \wedge \mu'(p) = r \wedge r < \text{Exp}(\mu'(p)) \wedge \exists u [\text{Agent}(u)(p)]] \\ \text{(type } \langle e, t \rangle \text{)}$$

The derived predicate denotes the set of reading processes with an Agent participant whose duration are less than the contextually determined expected duration. On uttering (1c), we assert the existence on a given occasion of a reading process belonging to this set. Formally, the process variable in the formula of (42) is existentially bound to get a proposition, i.e.,

$$\exists p [\text{czytać}(p) \wedge \mu'(p) = r \wedge r < \text{Exp}(\mu'(p)) \wedge \exists u [\text{Agent}(u)(p)]]^{24}$$

Now suppose that on uttering (1c) we had expected Irenka to read the newspaper for forty-five minutes. This fixes the value of  $\text{Exp}(\mu'(p))$  as 45 and the value of  $\mu'$  as that derived measure function which measures processes in minutes, i.e.,  $\mu' = \text{min}'$ . The setting of these values transforms the existentially quantified proposition into

<sup>23</sup> Actually, I suspect that *po-* does not assert the existence of an Agent for the process but instead semantically presupposes its existence. If correct, then if there is no Agent participant, as in (6a, 7a), the sentence is not false but rather simply difficult to evaluate. For simplicity, however, I leave the existence of an Agent as part of *po-*'s assertive meaning.

<sup>24</sup> For simplicity, I have not shown how the verb combines with its DP arguments.

$$\exists p[\text{czytać}(p) \wedge \min'(p) = r \wedge r < 45 \wedge \exists u[\text{Agent}(u)(p)]].$$

Assume that Irenka actually read for thirty minutes, i.e., the value of  $\min'$  when applied to the particular reading process in question is 30. The value of  $r$  is therefore 30, and the resulting proposition is now

$$\exists p[\text{czytać}(p) \wedge \min'(p) = 30 \wedge 30 < 45 \wedge \exists u[\text{Agent}(u)(p)]].$$

Since 30 is less than 40, the proposition is true, and so the reading process in question is in the denotation of  $\text{po-czytać}$ .

Suppose, however, that Irenka actually read for sixty minutes. If we keep the expected duration value constant at 45 minutes, then it is not true that 60 is less than 45 and so such a reading process is not in the denotation of  $\text{po-czytać}$ . In this case, (1c) does not truthfully describe the reading process in question.

Obviously, if there are no constraints on setting the expectation value  $\text{Exp}(\mu'(p))$ , then reading processes of any length can fall under the denotation of  $\text{po-czytać}$ , provided that the value of  $\text{Exp}(\mu'(p))$  is set high enough. But I assume that there *are* such constraints and that they serve to constrain the value of  $\text{Exp}(\mu'(p))$  in the context of a particular reading process. It is not the business of formal semantics, however, to tell us *how* a speaker determines the expected duration value for a particular reading process, as this calculation requires access to a lot of extralinguistic information (e.g., knowledge about the duration of reading processes in general, about how long Irenka tends to read the newspaper, etc.). The meaning of  $\text{po-}$  provides a parameter for the duration expectation value once we have calculated it, but it cannot tell us how to calculate it.

Given my analysis of  $\text{po-}$ , it should be clear why perfectives are compatible with durative adverbials, for in a significant sense,  $\text{po-}$  is a durative adverbial. Consider, for example, the cooccurrence of  $\text{po-czytać}$  with the durative adverbial *dwadzieścia minut* 'twenty minutes' in (20c). Suppose that durative adverbials are also analyzed as derived measure functions for processes, with the difference that they are VP-adjunctions.<sup>25</sup> Given that VPs are analyzed as one-place predicates of eventualities or times (cf. §1), it follows that durative adverbials, like  $\text{po-}$ , have the semantic type of modifier. Consequently, *dwadzieścia minut* in particular receives the translation in (43).

$$(43) \quad \begin{array}{l} \text{dwadzieścia minut, } [\alpha \text{ VP}] \text{ — VP} \\ \text{dwadzieścia minut} \Rightarrow \lambda Q \lambda p [Q(p) \wedge \min'(p) = 20] \\ \text{(type } \langle \langle e, t \rangle, \langle e, t \rangle \rangle) \end{array} \quad \text{'twenty minutes'}$$

<sup>25</sup> Krifka 1989a analyzes durative adverbials as measure functions in an event semantics with a single eventuality sort.

There is nothing to prevent the formula in (43) from applying to a perfective predicate, e.g., to  $\text{po-czytać}$ . The result of this functional application is given in (44).

$$(44) \quad \begin{array}{l} \text{po-czytać} \text{ } \text{dwadzieścia minut} \Rightarrow \\ \lambda Q \lambda p [Q(p) \wedge \min'(p) = 20] (\lambda p [\text{czytać}(p) \wedge \mu'(p) = r \wedge \\ \quad r < \text{Exp}(\mu'(p)) \wedge \exists u [\text{Agent}(u)(p)]]]) \Rightarrow \\ \lambda p [\text{czytać}(p) \wedge \mu'(p) = r \wedge r < \text{Exp}(\mu'(p)) \wedge \\ \quad \exists u [\text{Agent}(u)(p)]] \wedge \min'(p) = 20] \end{array} \quad \text{(type } \langle e, t \rangle \rangle$$

The addition of the durative adverbial restricts the denotation of  $\text{po-czytać}$  to those reading processes that last for twenty minutes, i.e., the value of  $\min'$  when applied to  $p$  is 20. But this automatically constrains the values of  $\mu'$  and  $r$ : if  $\mu'$  is  $\min'$ , then  $r$  must also be 20, because a function cannot yield different values for the same input.<sup>26</sup> Needless to say, in order for (20c) to be true, then the value 20 should be less than the expected duration value  $\text{Exp}(\mu'(p))$  in (44). In sum, it is evident that durative adverbials serve to linguistically specify the value of the measure function already asserted by the meaning of  $\text{po-}$ .

What perfectives have in common with imperfectives is that they denote processes and not events. Nevertheless, as the tests in §3 showed, perfectives clearly have a salient property in common with perfectives, therefore the analysis is not complete until we can state what this property is. Comrie (1976, 21) understands perfectivity as involving "lack of explicit reference to the internal temporal constituency of a situation." A more precise way of casting this idea is to say that perfectivity excludes reference to proper sub- eventualities of a complex eventuality in an algebraic part structure. The notion of *quantized reference* is apt for this purpose:<sup>27</sup>

$$(45) \quad \begin{array}{l} \forall Q [Q \text{ U A } (Q) \leftrightarrow \forall x \forall y [Q(x) \wedge Q(y) \rightarrow \neg y \leq x]] \\ (Q \text{ has quantized reference}) \end{array}$$

An eventuality predicate has quantized reference iff it follows that if an eventuality falls in its denotation, no proper part of that eventuality does. My claim is that all perfective predicates in Polish have quantized reference.

<sup>26</sup> Although nothing in the logical representation forces  $\mu'$  to be  $\min'$ , other choices for  $\mu'$  in (44) should yield values that are compatible with twenty minutes (e.g., a third of an hour). However, unless information is given to the contrary, it is reasonable to think that the linguistically specified measure function  $\min'$  determines the choice of  $\mu'$ .

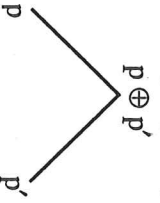
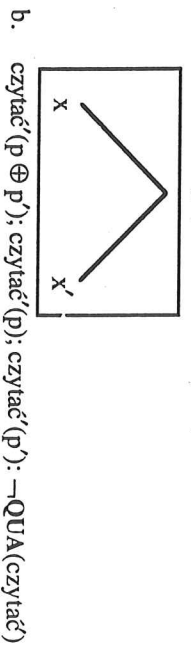
<sup>27</sup> I adopt the formulation in (45) from Krifka 1989b.

Consider first the case of event predicates like *prze-czytać*' in (1b). If this predicate truthfully refers to the event in question, then Irenka read the newspaper completely, i.e., it is not sufficient for Irenka merely to have read some of the newspaper. But this means that proper parts of the reading event do not fall in the denotation of *prze-czytać*, hence this predicate has quantized reference. Analogous reasoning applies to other standard perfective predicates as well, e.g., *na-pisać*' 'write', *wy-pić*' 'drink', and *z-jeść*' 'eat'.

Event predicates contrast in this regard with imperfective process predicates, which lack quantized reference. Consider *czytać*' 'read', which denotes the set of reading processes (cf. §1). If Irenka engages in a reading process of the newspaper and stops at some arbitrary time, it is still true that she engaged in a reading process of the newspaper. In other words, proper parts of a reading process are included in the denotation of *czytać*, hence this predicate lacks quantized reference. Again, the same reasoning applies to other imperfective predicates, e.g., *piś*' 'write', *pić*' 'drink', and *jeść*' 'eat'.

I depict this difference between event predicates and process predicates in (46). Event predicates like *prze-czytać*' apply to reading events but not to their proper parts. In (46a), I leave the sortal character of these parts an open question: minimally, they are not events (hence the box). Process predicates like *czytać*', on the other hand, apply to both reading processes and their proper parts, which again are processes, as shown in (46b).

- (46) a.  $\text{prze-czytać}'(e); \neg \text{prze-czytać}'(x); \neg \text{prze-czytać}'(x')$   
 $\text{QUA}(\text{prze-czytać}')$



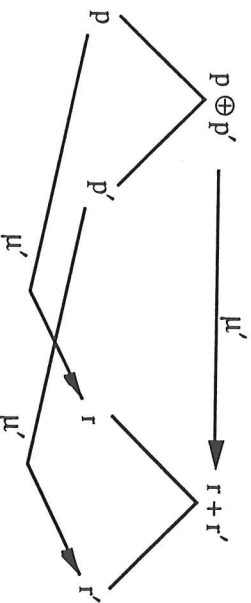
Let us now turn to perfective predicates—do they also have quantized reference? Note that nothing about quantized reference forces all quantized eventuality predicates to be event predicates. In other words, although all event predicates are

quantized, not all quantized eventuality predicates are necessarily event predicates. In particular, perfective predicates are quantized process predicates.

To see why, take *po-czytać*, whose semantic representation is given in (42). The question is, for any reading process that falls in the denotation of this predicate, whether its proper parts also fall in the denotation of *po-czytać*. If so, then *po-czytać* lacks quantized reference, and if not, then it has quantized reference. Intuitions are less robust in this case: a proper sub-process of a process of reading for a while may indeed seem to be a process of reading for a while. However, if the definition of quantized reference is applied to the representation of *po-czytać*<sup>28</sup> in (42), it turns out that *po-czytać* does have quantized reference.

The crucial point is that the derived measure function  $\mu'$  in (42) does not yield the same value when applied to a complex process and its proper sub-processes. Consequently, if *po-czytać* applies to a complex reading process, measuring it to have a certain duration, it cannot apply to reading processes that are its proper parts without measuring them to have durations less than that of the complex reading process. This situation is illustrated for the simple case of two sub-processes in (47). (For brevity, let  $\phi = \exists u[\text{Agent}(u)(p)]$ ; cf. (42).)

- (47)  $\text{czytać}'(p \oplus p') \wedge \mu'(p \oplus p') = r + r' < \text{Exp}(\mu'(p \oplus p')) \wedge$   
 $\exists u[\text{Agent}(u)(p)];$   
 $\text{czytać}'(p) \wedge \mu'(p) = r \wedge r < \text{Exp}(\mu'(p)) \wedge \exists u[\text{Agent}(u)(p)];$   
 $\text{czytać}'(p') \wedge \mu'(p') = r' \wedge r' < \text{Exp}(\mu'(p')) \wedge \exists u[\text{Agent}(u)(p')];$   
 $\text{QUA}(\text{po-czytać}')$



The demonstration of quantized reference for *po-czytać*' in (47) takes the following form.<sup>28</sup> We focus on the derived measure function  $\mu'$ , which is asserted by *po-czytać*'. Assume, contrary to what we want to prove, that *po-czytać*' lacks quantized reference, i.e., there are  $p_1, p$ , with  $p \leq p_1$ , and  $\mu'(p_1) = r_1, \mu'(p) = r_1$ . There is another process,  $p'$ , such that  $\neg p \leq p', \neg p' \leq p_1$ , and  $p \oplus p' = p_1$ . Recall

<sup>28</sup>See Krifka (1989b, 80) for a proof of quantized reference for additive measure functions in general.

that  $\mu'$  is defined in terms of  $\mu$  in (41a), a measure function for temporal traces of processes (cf. (39)). By (38a),  $\mu'(p) \leq \mu'(p_1)$  and  $\mu'(p) \leq \mu'(p_1)$ , and by (38b),  $\mu'(p) + \mu'(p') = \mu(p \oplus p') = \mu'(p_1)$ . By assumption,  $\mu'(p) = r_1$ , and we know that  $\mu'(p') > 0$ , hence  $\mu'(p) + \mu'(p') > r_1$ . But this means that  $\mu'(p_1) > r_1$ , which contradicts our original assumption that  $\mu'(p_1) = r_1$ . Consequently,  $\mu'$  does not apply to proper sub-processes with the same value, and so neither does the predicate *po-czytać*, hence *QUA(po-czytać)*. Clearly, the same reasoning extends to other pfective predicates.

In sum, pfectives are like standard pfectives in having quantized reference, and they are like imperfectives in denoting processes. In fact, they are just like process-denoting imperfectives with durative adverbials. The following table summarizes the properties of imperfectives, pfectives, and standard pfectives.<sup>29</sup>

(48)	Denotation	Quantized reference
Imperfectives	processes	no
Pfectives	processes	yes
Pfectives	events	yes

### 5.3 How the data pattern

The table in (48) shows how the three types of verbal predicates are classified according to the eventuality sort in their denotation and whether or not they have quantized reference. Since the data examined in §83–4 provided the empirical basis for the semantic characterization of pfective verbs, it is fitting to indicate which of these properties each piece of evidence is sensitive to. While there are surely subtleties among the data that await more precise characterizations, the following chart serves as a compendium of how the data pattern according to the two criteria set forth in (48):

(49)

	Denotation	Quantized reference
Present temporal reference (3.1)		no
Auxiliary aspectualizers (3.2)		no
Progressive interpretation (3.3)		no
Adverbial participles (3.4)		no
Present participles		yes
Perfect participles		yes
Passives (3.5)		yes
<i>zostać</i> <sup>P</sup> passive		no
<i>być</i> <sup>L</sup> passive		no
Temporal adverbials (4.1)	processes	
durative adverbials	events	
time-span adverbials	processes	
<i>do</i> meaning 'until'	events	
<i>do</i> meaning 'by'	events	
<i>prawie</i> 'almost' (4.2)	events	
<i>dalej</i> 'further' (4.3)	processes	no
<i>być</i> 'be' adjectival passive (4.4)	—[processes]	yes]
Quantificational interpretation (4.5)		
temporal <i>trochę</i> 'a little'	processes	
nominal <i>trochę</i> 'a little'	events	
temporal <i>ile</i> 'how much?'	processes	
nominal <i>ile</i> 'how much?'	events	
temporal <i>krótko</i> 'shortly'	processes	
nominal <i>krótko</i> 'shortly'	events	

Most of these contexts are sensitive to a single property and so are straightforward. Exceptions are the use of *dalej* 'further' (3.4) to assert immediate continuation of an eventuality, which requires non-quantized process-denoting predicates, and the adjectival *być*<sup>L</sup> passive, which excludes pfectives and pfectives, i.e., quantized eventuality-denoting predicates. In a more elaborate scheme, it would be desirable to state negative restrictions positively, i.e., to introduce a notion of *homogeneous reference* so that instead of (negatively) stating 'non-quantized reference' in (49) we could (positively) state 'homogeneous reference'. Homogeneous reference would characterize those predicates that apply both to the proper parts of entities and to their joins—precisely what the property of quantized reference forbids.

<sup>29</sup>In (48) I restrict my attention to non-stative imperfectives. I would argue that the fourth possible combination, viz., event-denoting predicates lacking quantized reference, does not (indeed, cannot) exist in Polish or in any language. However, careful discussion of this point is beyond the scope of the present paper.

A final remark concerns the interaction of the pofective with negation, specifically, the appearance of pofective verbs in negative sentences.<sup>30</sup> My account predicts that there should be no *semantic* difficulty in negating pofective verbs, for nothing prevents one from denying the existence of a process whose duration is determined by an implicit measure function. Consequently, if the occurrence of pofectives in negative sentences is rare or odd, it is for another reason.<sup>31</sup>

- (50) a. ?Irenka nie po-czytała gazety dziś rano.  
Irenka NEG read newspaper.GEN today morning  
'Irenka did not read the newspaper for a while this morning.'  
b. ?Nie po-pracowaliśmy wczoraj wieczorem.  
NEG worked.we yesterday evening  
'We didn't work for a while yesterday evening.'  
c. ?Bożena nie po-piła kawy o dziesiątej.  
Bożena NEG drank coffee.GEN at ten.GEN  
'Bożena didn't drink coffee for a while at ten o'clock.'

Polish speakers do not reject the sentences in (50) as syntactically ill-formed or semantically incoherent. On the contrary, they consider them perfectly felicitous if properly contextualized.

With pofective verbs, negation is *external*, taking scope over all the conjoined formulae in the meaning representation of *po-* (cf. (41b)). Crucially, it cannot take scope over any one of the formulae alone, i.e., negation cannot be *internal* with pofectives. Consequently, if Irenka reads the newspaper for a long time today, it is not possible to use the sentence in (50a) to assert that she did indeed read, but not for a short time. (50a) can only be used to deny the claim that she both read and read for a short time. In order for sentences like those in (50) to be felicitous, we have to find contexts in which this external negation is justified.

Suppose, for example, that Irenka usually reads the newspaper for a short time in the morning. It is a part of her daily routine, both the speaker and hearer know this, and they moreover expect her to read the newspaper for a while each

<sup>30</sup>Sergey Avrutin raised this issue after the public presentation of the paper.

<sup>31</sup>Akimova (1992, 43), in a brief discussion of delimitives in Russian, maintains that they can be negated. Unfortunately, however, she provides no example with a negated pofective verb. Nevertheless, her example (34) *My ne pro-govorili s 6 do 7* 'We did not talk from 6 to 7' nearly makes the case for negated pofectives, because I would argue that the prefix *pro-* (Polish *prze-*), which typically describes longer than expected duration, shares the crucial properties (i.e., process denotation, implicit measure function) with *po-*.

morning. Suppose now that she does not read the newspaper at all today, a surprising fact in view of the common expectation that she would read it for a while. In this context, (50a) could be uttered felicitously. (50b–c) require similar contextual support.

With simple assumptions about the pragmatics of entailment scales, it is possible to account for why such contextual support is needed. Observe that pofectives semantically entail their imperfective counterparts, e.g.,  $[[po-czytać]^{M,8} \subseteq [czytać]^{M,8}]$ . This follows from my semantic representation for *po-* in (41b), in which the imperfective predicate is entailed as one of the conjoined formulae. The reverse, of course, does not hold, because a process denoted by *czytać* may not fall in the denotation of *po-czytać* (precisely when the particular reading process lasts too long). Thus in a positive sentence it is more informative to use *po-czytać* than *czytać*, if the extra information about relatively short duration is relevant (the Gricean principle of Quantity; cf. Horn (1989, 194)).

It is well-known that negation reverses such entailments (Horn (1989, §4)). Consequently, if we deny the existence of a reading process described by *czytać*, this entails that no reading process describable by *po-czytać* occurred, i.e., not reading at all entails not reading for a while. Therefore, it is more informative (and hence more felicitous) to use *czytać* than *po-czytać* in negating the existence of a reading process. In general, negating the existence of processes with imperfective verbs is more informative than negating their existence with the corresponding pofectives.

The negative sentences in (50) are less informative than their counterparts with imperfective verbs. If we assume a cooperative speaker, then there should be a good reason why s/he does not choose instead to negate the existence of a process with the corresponding imperfective verbs. Clearly, to negate both the existence of a process and the fact that the process was relatively short is relevant only if the context supports the claim or expectation that was to have been not just a process, but a relatively short process, in the first place.<sup>32</sup> However, if we assume that contexts generally do not support such a claim or expectation about particular processes, negative sentences with pofective verbs will generally be less informative (and therefore less felicitous) than those with their corresponding imperfectives. Thus the pragmatics of informativeness is what underlies the oddness of uncontextualized negative sentences like those in (50).

<sup>32</sup>Horn (1989, 195): "... a speaker's use of a weaker form may be filled in by an addressee who recognizes that some particular stronger or more informative meaning may have been intended."

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