A unified analysis of the habitual and in-progress readings of *á* in Blackfoot*

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Abstract

Forms labeled "imperfective" across a number of languages exhibit two distinct meanings: an *in-progress* interpretation and a *habitual* interpretation. The verbal prefix *á-* in Blackfoot has several properties (including use in expressing the above two meanings) that indicate it is the functional equivalent of so-called imperfectives in Indo-European (IE) languages. Following in the work of Bonomi (1997) on the Italian *imperfetto*, this paper argues for a unification of the in-progress and habitual readings of *á-* in Blackfoot. The amenability of Bonomi's analysis to Blackfoot constitutes an argument for its adoption in language-particular semantic analyses of what appears to be a cross-linguistic semantic class: the imperfective.

1 Introduction and a puzzle

It is indicative of the embryonic state of our understanding concerning the various phenomena clustered together under the label *aspect* that the following vague definition has remained pertinent for some thirty years: "[aspects] are different ways of viewing the internal temporal constituency of a situation" (Comrie 1976, p. 3). A paradigmatic example of aspect would appear to be the *imperfective* (exemplified by verbal affixes of the same name in Romance languages as well as the English progressive construction (cf. Comrie (1976)).[1] Klein (1994), making use of the idea of Reichenbach (1947) that

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[1]While Comrie (1976) does classify the English progressive as a type of imperfective and while I follow this usage, it should be made clear that it is a subtype of imperfective with further restrictions, in particular a general incompatibility with lexically stative predicates. While I do, in the course of the paper, refer to the English progressive as an imperfective, this is not meant to suggest that the semantic analysis here presented

aspects denote relations between a reference time (RT) and an event time (ET), proposes that the imperfective denotes an internal view of an event by forcing the RT to be a subinterval of the ET. The broad acceptance of this view (see, for example, Kratzer (1998) and many others) belies the fact that imperfectives in many Indo-European languages have a second function, namely the denotation of a habitual (iterative) event.

This paper presents data from Blackfoot (an Algonquian language of North America) showing that the morpheme *á-* possesses several properties claimed for IE imperfectives, including crucially its two most salient interpretations: in-progress (the internal view of the event) and habitual (the view of an event's occurrence as characteristic of a given interval) (cf. Dunham (2007)). Following Bonomi's analysis of the Italian imperfetto, I propose a unification of these two interpretations based on the idea that the imperfective and the perfective are operators, the former associated with universal and the latter with existential quantification over events. More concretely, the imperfective predicates properties of all events within a given interval while the perfective declares the existence of an event of a given type within a given interval. In this model, additional information about the duration of this interval (whether contextually salient or explicit) results in a preference for or an exclusion of one of the two interpretations: habitual or in-progress.

Blackfoot *á-* differs from Italian *imperfetto* in that tense information (here understood as a specification of the relation between the time of utterance (UT) and the RT) is independent morphologically from aspectual information insofar as *á-* may be used in the denotation of past *and* present habitual and in-progress events. While this parallels the independence of tense and aspect in the English imperfective form (cf. the contrast between the progressive forms *was running* and *is running*), Blackfoot differs in that the tense information (if we can truthfully speak of tense as a grammaticalized concept of Blackfoot (cf. Ritter and Wiltschko (2005)) appears not to be encoded by phonologically overt morphemes (cf. Matthewson and Silva (2007)). This means that a single *á-*prefixed form[2] can potentially have up to four readings: present and past habitual, and present and past in-progress. I argue that the model of Bonomi (1997) can, with slight modification, account for these readings where the Reichenbachian one cannot.

This paper is structured as follows. In §2 I present Blackfoot data from elicitation and argue first that *á-* has all the properties claimed of other morphemes labeled imperfective, second that *á-* IMPF must be distinguished from *a(')-* 'when' and finally that *á-* has the four readings mentioned above. In §3 I put forward Bonomi's analysis of the Italian imperfetto. §4 shows how this analysis generates the correct semantics for Blackfoot *á-* given additional assumptions about Blackfoot tense marking. Finally, §5 summarizes the argument and considers some unresolved issues.

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can be applied to the progressive. The nature of the relation between imperfectivity (in the narrow sense where the term excludes progressivity) and progressivity is an interesting focus of study but one that is not taken up in the present work.

[2]Technically, given the assumption of phonologically null past and present tense, a form used to express *past* habitual and in-progress meaning will be distinct from a form used to express *present* habitual and in-progress meaning—even though the forms will sound indistinguishable! Unless a derivation is being given, I will in general avoid making the null past and present morphemes explicit. The reader can surmise which is underlying given the English translation.

1.1 Preview of the puzzle

The Blackfoot *á*-prefixed forms (1, 2), the Italian forms with the (past) imperfective suffix (3) and the English present (4) and past (5) progressive forms all possess an in-progress/ habitual ambiguity.[3,4]

(1) *nitáó'tsisi*
nit-**á**-o'tsisii
1-**IMPF**-smoke(vai)
'I smoke' (HABITUAL)
'I am smoking' (IN-PROGRESS)

(2)

nitáístsitso'tatsimasii	*annahk*	*Martina*
nit-**a**-isttsitsa-o'táaatsiim-aa-hsi	ann-wa-hka	Martina
1-**when**-first.time-meet(vta)-DIR-CONJ	DEM-PROX-INVS	martina

áótsisi
á-o'tsisii
IMPF-smoke(vai)
'when I first met Martina she was a smoker' (HABITUAL)
'when I first met Martina she was smoking' (IN-PROGRESS)

(3)

Leo	*giocava*	*a*	*golf*
Leo	gioca-**va**	a	golf
Leo	play-**PAST.IMPF**	PREP	golf

'Leo used to play golf' (HABITUAL)
'Leo was playing golf' (IN-PROGRESS)

(4) a. 'I **am** smok**ing/** play**ing** golf (these days)' (HABITUAL)[5]

[3]Guide to abbreviations: 1=first-person; 2=second-person; 3=third-person; 4=obviative third-person; 21=first-person plural inclusive; SG=singular; PL=plural; AN=animate; IN=inanimate; IMPF=imperfective (previously DUR=durative); PAST=past; DEM=demonstrative; CONJ=conjunctive; TI.THM=transitive inanimate theme suffix; NEG=negation; PRO='attached pronoun'; NONAFF=nonaffirmative suffix; NONPAR=nonparticular; INT=intensifier; PAST.HAB=past habitual; SUBJ=subjunctive; INCH=inchoative; INV=inverse; DIR=direct; (vai)=animate intransitive verb; (vii)=inanimate intransitive verb; (vta)=transitive animate verb; (vti)=transitive inanimate verb. The Blackfoot orthography as used in Frantz and Russell (1995) is used throughout the present paper and is for the most part transparent in terms of character-to-phoneme mappings. The following tips will help to decipher those few unclear aspects of the orthography: an apostrophe " ' " indicates a glottal stop, and acutely accented vowels represent some type of prosodic prominence, sometimes argued to be pitch accent.

[4]Where Blackfoot forms have (HABITUAL) or (IN-PROGRESS) in the gloss, this indicates that the interpretation is based not only on the interpretations available to the English translation but also on comments given by the consultant as well judgments on the felicity of the forms with imagined scenarios. Thus, for example, (1) could be used when talking on the phone and giving an explanation for one's laboured breathing or in response to a question about one's tobacco-consuming habits.

[5]In response to the objection that the English progressive is not commonly used to express habitual meaning, I refer the reader to examples (i) and (ii) taken from a popular Youtube video.

The context is as follows. Standup comedian Sara Silverman is confessing, via a music video, to her latenight talkshow host boyfriend Jimmy Kimmel that she is cheating on him with Matt Damon. The refrain is as in (i).

(i) I'm fucking Matt Damon

b. 'I **am** smok**ing/** play**ing** golf (right now)' (IN-PROGRESS)

(5) a. 'I **was** smok**ing/** play**ing** golf (in those days)' (HABITUAL)

b. 'I **was** smok**ing/** play**ing** golf (when I had a stroke)' (IN-PROGRESS)

That a single form should, across a variety of languages, have a systematic in-progress/ habitual ambiguity seems unlikely. A more probable state of affairs is that these cross-linguistic imperfectives share a single semantic denotation and that this denotation or meaning is somehow responsible for the habitual and in-progress readings. The bringing to light of this single denotation is the puzzle that this paper seeks to solve.

2 *Á-* in Blackfoot

This section presents a set of facts about the morpheme *á-* in Blackfoot. In subsection §2.1, I argue that *á-* deserves to be labeled imperfective insofar as it shares the salient properties of the other morphemes/ constructions so labeled. In subsection §2.2, I put forward evidence in favour of a homophonous (or near-homophonous) morpheme *a'-* which ought not to be confused with *á-*. In subsection §2.3, I discuss the objection to the present analysis that claims *á* is an instance of a typically Algonquian verbal alternation termed "Initial Change" which, although it can appear so, is not in fact aspectual in nature. Finally in subsection §2.4, I underscore the point that *á-*prefixed forms are used in expressing past and present habitual and in-progress interpretations.

2.1 *Á-* is imperfective-like

Á- shares with cross-linguistic imperfectives the properties of (1) being used to express in-progress meaning, (2) being used to express habitual meaning, (3) having a modal component (in that the so-called *Imperfective Paradox* (cf. Dowty (1979)) arises with its use), and (4) being compatible with lexically stative verbs.

Properties (1), (2) and (4) are recognized as characteristic of cross-linguistic imperfectives by Comrie (1976). Property (4), the modal component, has been much discussed with reference to the English progressive construction (see, for example, Dowty (1979); Landman (1992)) but appears to be a property of imperfectives as well (Dunham (2007)). This leaves the distinction between the progressive and the imperfective lying primarily with property (4)—progressive forms are generally less acceptable with stative verbs—and to some extent property (2)—while progressive forms *can* be used to express habitual meaning (cf. examples 4, 5) they are not as commonly employed to do so as imperfective forms.

(ii) When I told you I was fucking Matt Damon, I WAS fucking Matt Damon.

Interestingly, (ii) shows that the predicate *fucking Matt Damon* can be used twice in a single sentence with the first token expressing habitual interpretation and the second in-progress. While there may be subsets of English predicates that do not allow this dual usage, these examples plainly show that English progressive forms are used ambiguously to express both habitual and in-progress meaning.

2.1.1 In-progress reading

Á-prefixed forms are used to denote events that are viewed as in the process of unfolding or, in other words, are in progress at a given temporal interval *t*. In this paper such an interpretation is labeled *in-progress*. When the interval *t* is located before the UT, the interpretation is *past in-progress* and when *t* is located at or is a superinterval of the UT, the interpretation is called *present in-progress*.

With the temporal adverbial *annohk* 'now', *á*-prefixed forms have present in-progress meaning (6) while bare forms (i.e., those not prefixed by *á*-) do not (7).

(6) *nitáíhpiyi* *annohk*
nit-**á**-ihpiyi annohk
1-**IMPF**-dance(vai) now
'I am dancing'

(7) **nítsspiyi* *annohk*
nit-ihpiyi annohk
1-dance(vai) now
Speaker's comment: "that would mean 'I danced now' "

With the temporal adverbial *matónni* 'yesterday' and an *á*-less when-clause, *á*-prefixed forms have past in-progress (8) meaning while bare forms do not (9).

(8) *otao'toohsi* *matónni* *anná* *John* *anná* *Mary*
ot-a'-o'too-hsi matónni ann-wa John ann-wa Mary
3-when-arrive-CONJ yesterday DEMPROX John DEMPROX Mary
áíhpiyi
á-ihpiyi
IMPF-dance
'Yesterday Mary was dancing when John came'

(9) *otao'toohsi* *matónni* *anná* *John* *anná* *Mary* *íhpiyi*
ot-a'-o'too-hsi matónni ann-wa John ann-wa Mary ihpiyi
3-when-arrive-CONJ yesterday DEMPROX John DEMPROX Mary dance
'Yesterday Mary (had already) danced when John came'
*'Yesterday Mary was dancing when John came'

2.1.2 Habitual reading

In addition, *á*-prefixed forms are used to denote events that are viewed as characteristic of a given interval *t*. I call this the *habitual* reading. Like in-progress above, *past habitual* readings refer to characterizations of intervals anterior to the UT and *present habitual* readings refer to characterizations of intervals that are supersets of the UT.

Á-prefixed forms can be used to express present habitual readings (10) but bare forms cannot (11).

(10) *áa nitáó'tsis*
áa nit-**á**-o'tsisii
yes 1-**IMPF**-smoke
'Yes, I smoke'

(11) *áa nitóó'tsis*
áa nit-o'tsisii
yes 1-smoke
'Yes, I smoked'
*'Yes, I smoke'

Given the appropriate context, *á*-prefixed forms can also be used to express past habitual meaning. The example in (12) is from a story told by the consultant and the context in which it occurs (in addition to the use of "would" in the English translation) makes it clear that the speaker is describing the typical activities of the woman in an interval that is located "a long time ago".

(12) *ámo kiisskoohtsik ... ki ma aakii mi*
ámo kiisskoohtsik ... ki m-wa aakíí m-yi
DEM long.time.ago ... and DEM-PROX woman DEM-OBV
áísikapistotsim ...
á-isikk-apistotsim
IMPF-clean-make ...
'A long time ago ... And the woman would clean up ...'

In spite of (12), past habitual meaning is more commonly expressed in the elicitation context with the prefix *aisooka-* 'used to' (13). It appears that the consultant's default translation for English 'used to' sentences is to use the *aisooka*-prefixed form; in cases where the consultant is not performing a translation task, the *á*-prefixed form is freely used to express past habituality.

(13) *nitáísookaisimi*
nit-**aisooka**-simi
1-**PAST.HAB**-drink
'I used to get drunk'

2.1.3 Modal component

Á-prefixed telic predicates (i.e., those with a lexically-specified endpoint or *telos*) can refer to a non-culminated (i.e., incomplete) event. In contrast, bare telic predicates can only refer to events that must have culminated. This phenomenon is often given the label *Imperfective Paradox* (Dowty 1979) and although it may be best known from its discussion with respect to the English progressive construction (Landman 1992; Parsons 1989), I argue elsewhere (cf. Dunham (2007)) that it is typical of the larger class of non-progressive imperfectives as well.

Several analyses of the English progressive and its Imperfective Paradox appeal to some notion of normalcy (cf. the *inertia worlds* of Dowty (1979) or the *continuation branches* of Landman (1992)) and argue that telic predicates in the progressive denote events that culminate in all these normal worlds. This is the sense in which the Imperfective Paradox phenomenon is said to be modal.

That *á*-prefixed telic predicates (14) can refer to a non-culminated event while *á*-less forms (15) cannot is shown by the fact that the former but not the latter can be conjoined with a phrase that overtly negates the event's culmination.

(14) *ayákokii* *matónni* *ki* *annohk* *sáákyayákokii*
á-yáakokiiyi matónni ki annohk saaki-**á**-yáakokiiyi
IMPF-erect.tipi(vai) yesterday and now still-**IMPF**-erect.tipi(vai)
'he was putting up his tipi yesterday and right now he's still putting it up'

(15) **iyákokii* *matónni* *ki* *annohk* *sáákyayákokii*
i-yáakokiiyi matónni ki annohk saaki-**á**-yáakokiiyi
?-erect.tipi(vai) yesterday and now still-**IMPF**-erect.tipi(vai)
Target: 'he was putting up his tipi yesterday and right now he's still putting it up[6]'

2.1.4 Statives

Á- can be prefixed to stative predicates resulting in a habitual interpretation, i.e., one where a state that is viewed as temporary repeatedly comes to hold of an individual (17). *Á*-less forms tend to have an interpretation where the state is understood to hold at the RT (16).

(16) *anna* *Joel* *iksspita*
ann-wa Joel iik-sspita
DEM-AN.SG Joel INT-tall
'Joel is tall'

(17) *anna* *Joel* *áísspita*
ann-wa Joel **á**-sspita
DEM-AN.SG Joel **IMP**-tall
'Joel gets tall'
*'Joel is tall'

- Speaker's comment: this can be said in a context where Joel habitually gets tall by, for example, taking a magical pill.

The compatibility of *á* with stative predicates is evidence that it is more imperfective- than progressive-like since the progressive is generally held to be less acceptable with statives than other lexical verb types (cf. **/? John is knowing the answer*). See Dunham (2007) for further discussion of the behaviour of *á*- with stative predicates.

[6]The question mark "?" in the morpheme gloss indicates that there is no consensus on the meaning of this morpheme nor whether it is in fact a morpheme and not the result of a purely phonological alternation.

Having shown that *á-* shares many semantic properties with morphemes labeled *imperfective* in other languages, we now turn to the distribution of *á-* and particularly to the importance of distinguishing *á-* IMPF from its nearly homophonous doppelganger *a'-* 'when'.

2.2 *Á-* IMPF versus *a(')-* 'when'

Á- is a morpheme that occurs in complex verbal forms to the left of the verb stem and to the right of the person prefixes *nit-*, *kit-* and *ot-*. As we will have reason to analyze when-clauses in the coming sections, and because the Blackfoot analog of English 'when' is very similar to imperfective-like *á-* both in its position within the verbal complex and in its phonological form, it will be important to briefly go through data evincing the distinction between these two morphemes.

Consider the example in (18). Note that in the when-clause there is a morpheme phonologically very similar to *á-* IMPF and located between the person prefixes and the verb stem. If this morpheme were in fact *á-* IMPF, we might, given the previous discussion, expect the event denoted by the when-clause to have either a habitual (*Tom would come/ comes in*) or an in-progress (*Tom is/ was coming in*) interpretation but certainly not the *completed-event* interpretation suggested by the consultant's offered translation[7]. This is a problem for the present analysis of *á-* as a marker of imperfectivity.

(18)	*ann*á	*Martina*	*itsspí-yi*	*anni*	*Tom*	*ot*á*i'pissi*
	ann-wa	Martina	iit-ihpiyi	ann-yi	Tom	ot-**a'**-ipii-hsi
	PROX-AN.SG	Martina	LOC-dance	DEM-OBV	Tom	3-**?**-enter(vai)-CONJ
	'Martina danced when Tom came in'					

I argue that the mysterious morpheme in (18) and similar examples is not actually *á-* IMPF but rather the *a'-*, variably glossed as 'inchoative (INCH)' (Frantz 1991, p. 97, 113) and 'when' (Frantz 1971; Taylor 1969, p. 322). The claim is that *a'-* actually marks temporal coincidence between the events denoted by two clauses (much like *when* in English or *quando* in Italian). The assumptions of this claim are made explicit in (19).

(19) DISTRIBUTION OF [a]-LIKE MORPHEMES:

1. When-clause predicates must contain exactly one *a'-* 'when' morpheme
2. Any type of clause may contain either zero or one (but no more) *á-* imperfective (IMPF) morphemes
3. Absence of *á-* IMPF signifies default perfective (PERF) aspect

[7]Of course, the English translation is also (though less readily) compatible with a past habitual interpretation: '*In those days* Martina danced when Tom came in.' Further elicitation is required to ensure conclude unequivocally that (18) does not have past habitual meaning.

2.2.1 Ungrammaticality of *a-a-* in main clauses

The assumptions outlined in (19) predict that a sequence of two [a]-like morphemes (henceforth *a*s) should be possible only in when-clauses but never in main clauses.

Examples (20-22)[8] show that this prediction is borne out. No matter how the pre-verb-stem morphology is varied in the when-clause, a sequence of two *a*s prefixed to the main clause verb always results in ungrammaticality. (Note: the when-clauses are identifiable by the presence of conjunct morphology[9] on the verb).

(20) **otá'yaihpiyi'si anná John, anná Amelia ayainihki*
ot-**a**-**a**-ihpiyi-'si ann-wa John, ann-wa Amelia **a**-**a**-inihki
3-**?**-**?**-dance-CONJ DEM-PROX John DEM-PROX Amelia **?**-**?**-sing
Target: 'When John DANCE, Amelia SING'

(21) **otáíhpiyi'si anná John, anná Amelia ayainihki*
ot-**a**-ihpiyi-'si ann-wa John, ann-wa Amelia **a**-**a**-inihki
3-**?**-dance-CONJ DEM-PROX John DEM-PROX Amelia **?**-**?**-sing
Target: 'When John DANCE, Amelia SING'

(22) **otsspiyi'si anná John, anná Amelia ayainihki*
ot-ihpiyi-'si ann-wa John, ann-wa Amelia **a**-**a**-inihki
3-dance-CONJ DEM-PROX John DEM-PROX Amelia **?**-**?**-sing
Target: 'When John DANCE, Amelia SING'

2.2.2 When-clauses lacking *a-*

If a when-clause lacks the morpheme *a-* 'when', we might expect, given (19), that the entire when-construction will be ungrammatical. That this is in fact the case is shown by (23).

(23) **otsspiyi'si anná John, anná Amelia ainihki*
ot-ihpiyi-hsi ann-wa John, ann-wa Amelia **á**-inihki
3-dance-CONJ DEM-PROX John, DEM-PROX Amelia **IMPF**sing
Target: 'When John DANCE, Amelia SING'

Interestingly, the one form I have tested with an *a*-less when-clause and an *a*-less main clause is judged grammatical by the consultant but is translated as a different type of subordination structure: a 'that'-construction (24).

(24) *anna Martina iikóóki'taki anni Tom otsípissi*
ann-wa Martina iik-ok-i'taki ann-yi Tom ot-ipii-hsi
DEM-PROX martina INT-bad-feel DEM-OBV Tom 3-enter-CONJ

[8]These judgments were elicited in the following manner. I produced the forms for the consultant and she accepted or rejected them. Cases where a glottal stop is transcribed or where an *a* bears prominence (i.e., is accented) are the result of a transcription of the manner in which the consultant parroted the forms back to me.

[9]Conjunct morphology in Blackfoot refers to a paradigm of person agreement suffixes that tend to be used on verbal forms in subordinate clauses (see Frantz (1991, pp. 111-112)).

'Martina was really mad about Tom coming in/ that Tom came in/ about the fact that he dared to come in'

That subordinate clauses lacking *a-* are either ungrammatical (23) or not when-clauses is further evidence for the claim that there are two *a*-like prefixes: 'when' and IMPF.

2.2.3 Well-formed when-constructions

As expected given our assumptions in (19), when-constructions are grammatical when they consist of a when-clause with at least one and at most two *a*s and a main clause with zero to one *a*s (25-28).

(25)

otáí'ihpiyi'si	*anná*	*John,*	*anná*	*Amelia*	*iin'ihkíí*
ot-**á'**-ihpiyi-hsi	ann-wa	John,	ann-wa	Amelia	inihki
3-**when**-dance-CONJ	DEM-PROX	John	DEM-PROX	Amelia	sing

'When John went up to dance/ was dancing, Amelia sang'

(26)

kitáí'pissi	*nitáó'ihpinnaan*
kit-**á'**-ipii-hsi	nit-**á**-oyii-hpinnaan
2-**when**-enter-CONJ	1-**IMPF**-eat-1PL

'When you came in, we were eating'

(27)

otá'yaihpiyi-'si	*anná*	*John,*	*anná*	*Amelia*	*iinihkíí*
ot-**a'**-**á**-ihpiyi-hsi	ann-wa	John,	ann-wa	Amelia	inihki
3-**when**-**IMPF**-dance-CONJ	DEM-PROX	John	DEM-PROX	Amelia	sing

'When John was dancing, Amelia sang'

(28)

otá'yaihpiyi-'si	*anná*	*John,*	*anná*	*Amelia*
ot-**a'**-**á**-ihpiyi-hsi	ann-wa	John,	ann-wa	Amelia
3-**when**-**IMPF**-dance-CONJ	DEM-PROX	John	DEM-PROX	Amelia

áínihki
á-inihki
IMPF-sing

'When John was dancing, Amelia was singing'

We have not yet discussed the proposed semantic analysis of imperfective and perfective forms and therefore cannot yet account for the interpretations implied by the English translations. We may observe, however that all the verb forms in (25-28) that are assumed to contain *á-* IMPF have a translation into English where the corresponding verb bears progressive aspect. I take this as further evidence for the position that there are two distinct *a*s with distributions as described in (19).

2.2.4 When-clauses in the subjunctive mood

The when-constructions we have viewed up until this point have all had conjunctive morphology on the verb of the when-clause. There is another class of when-constructions wherein the verb in the when-clause bears subjunctive morphology. Frantz

(1991, p. 110) states that the subjunctive is used in "clauses which are 'presumptive' or 'conditional' in meaning." This assertion fits well with the observation that the following subjunctive when-constructions all denote present habitual correlations between events, denotations that may be paraphrased using a conditional: *for all times t, if A occurs, B occurs also*.

In terms of the presence of *a*-like prefixes on the verb stems of these subjunctive when-constructions, the only constraint appears to be that the main clause be prefixed with a single *á-* IMPF (29-31)[10]—all possible permutations of the when-clause are possible.

(29)

ayáíhpiyisi	*anná*	*John,*	*anná*	*Amelia*	*áínihkii*
a'-**á**-ihpiyi-**si**	ann-wa	John,	ann-wa	Amelia	**á**-inihki
when-**IMPF**-dance-**3.SUBJ**	DEM-AN.SG	John	AN.SG	Amelia	**IMPF**-sing

'when John is dancing, Mary is singing'

(30)

annaahka	*Martina*	*iikáókimmi*	*anni*	*Tom*
ann-wa-hka	Martina	iik-**á**-okimmi	ann-yi	Tom
DEM-PROX-INVS	Martina	INT-**IMPF**-be.mad	DEM-OBV	Tom

aipíssi
a'-ipii-**si**
when-enter-**3.SUBJ**

'Martina gets mad at Tom when he comes in'

(31)

ihpiyisi	*anná*	*John,*	*anná*	*Amelia*	*áín'ihkii*
ihpiyi-**si**	ann-wa	John,	ann-wa	Amelia	**á**-inihki
dance-**3.SUBJ**	DEM-PROX	john	DEM-OBV	amelia	**IMPF**-sing

'Amelia is singing when John is dancing/ starts to dance'

It is not, at present, clear just how the readings implied by the English translations in (29-31) fall out from the semantics of *á-* IMPF, *a'-* 'when' and *-si* 3.SUBJ to be given below. The analysis of (30) is further complicated by the fact that an *á*-prefixed stative verb occurs in the main clause (cf. §2.1.4 above). These cases and the challenges they present are discussed in greater detail in §4 where the analysis of Bonomi (1997) is applied to the Blackfoot facts.

In this section we have seen that there are good arguments for distinguishing *á-* IMPF from *a'-* 'when.' This means that cases where a verb appears to have two imperfective prefixes or cases where a verb appears to have an imperfective marker but lacks either the in-progress or habitual reading are in fact illusory. In the next section I underscore the presence of habitual and in-progress readings for *á*-prefixed forms and argue for the inadequacy of the Reichenbachian model.

2.3 Initial change objection

In this section I respond to possible objection to the present analysis, namely that the apparent aspectual nature of *á-* is somehow epiphenomenal and that its true function is

[10]For reasons of space, the ungrammatical forms where the main clause verb is prefixed by (i) both *a'-* and *á-* or (ii) neither are not given here.

to mark clause structure in some as yet poorly understood way. For reasons that will shortly become clear, I call this the *initial change* (IC) objection.[11]

In many Algonquian languages there is a morpho-phonological process known as initial change which affects the vowel quality of the leftmost vowel of the verbal complex. The semantic and syntactic role of IC is less clearly understood than its morphophonology. While it is sometimes treated as a marker of progressive or imperfective aspect in certain Cree learning grammars, Cook (p.c. and forthcoming) argues that IC in Cree is in fact not an aspectual marker but that it serves to indicate clause type.

Several researchers (cf. Taylor (1967); Proulx (2005)) have argued that IC is present in Blackfoot. Taylor (1967) has the following to say about the presence of IC in Blackfoot.

> "Beginning as an identifying feature of particular dependent modal forms, initial change passed on in Blackfoot to become the mark of certain roots when in initial position in any finite verbal form, and, beyond this, a sporadically attested tendency exists to employ initial change as the mark of the root when in initial position in any verbal form" (Taylor 1967, p. 150).

He gives the table in (32) as a synopsis of IC in Blackfoot.

(32) IC in Blackfoot (Taylor (1967))

	UNCHANGED	CHANGED
generally facultative	-ii-	-aa-
	-oo-	-aa-
	-i-	-aa-
	-o-	-aa-
	ø-	-ay-
obligatory	-i-	-ii-
	-o-	-oo-

If Taylor (1967) is right, then IC in Blackfoot does not mark clausal dependency but simply highlights a stem-initial root.

There is in fact some indication that the phenomenon I have been describing as prefixation of the morpheme *á-* could arguably be called a form of initial change. Perhaps reminiscent of the alternations given in the first four rows of table (32), when *á-* is prefixed to *i-* or *o-*initial forms the result is a monophthong [ɛ] or [ɔ] respectively instead of the [ai] or [ao] diphthongs we might expect.[12] However, it is clear that the the CV to CayV alternation discussed in Taylor (1967) (and schematized on the fifth row of (32)) is not present in the speech of my consultant.

An additional property of pan-Algonquian IC (as alluded to in the quotation from Taylor (1967) above) is that it tends to be confined to particular types of subordinate

[11] My thanks to Clare Cook, Jeff Meuhlbauer and Shujun Chin who brought this objection to my attention.

[12] See, for example, the contrast between examples (8) and (9) above where the verb meaning 'dance' begins with a phonetic [ɪ] in the form that I analyze as lacking the prefix *á* (i.e., *ihpiyi*) and begins with a phonetic [ɛ] in the form here analyzed as having the prefix *á* (i.e., *áíhpiyi*.

clause (cf. Valentine (2001)). This property is in fact more reminiscent of the phenomenon I have been following Frantz (1991) and Frantz (1971) in referring to as *a'* 'when'/INCH which, as we have seen, appears to be confined to subordinate clauses with conjunctive or subjunctive morphology.

It is clear that what is needed is further research into the role (if any) that initial-change or initial-change-like phenomena play in Blackfoot. Once this is achieved, we may then be able to give a satisfactory response to the question of how IC bears upon the semantic and morphosyntactic claims here made about the morpheme *á-*.

2.4 *Á-* expresses past and present habituality and in-progressivity

Sentences (1, 2) repeated here as (33, 34) show that an *á*-prefixed verb can denote an event that is viewed either as in progress at or characteristic of a salient (past or present) RT.

(33) *nitáó'tsisi*
nit-**á**-o'tsisii
1-**IMPF**-smoke(vai)
'I smoke (HABITUAL)/I am smoking (IN-PROGRESS)'

(34)

nitáístsitso'tatsimasii	*annahk*	*Martina*
nit-**a**-isttsitsa-o'táaatsiim-aa-hsi	ann-wa-hka	Martina
1-**when**-first.time-meet(vta)-DIR-CONJ	DEM-PROX-INVS	martina

áótsisi
á-o'tsisii
IMPF-smoke(vai)
'when I first met Martina she was a smoker (HABITUAL)/ was smoking (IN-PROGRESS)'

Let us consider example (1/33) and how its denotation would be calculated on the analysis of Kratzer (1998)[13]. We will take the meaning of the imperfective from Kratzer (1998, p. 17), which essentially forces a RT *t* to be a subinterval of the interval during which the event denoted by the proposition occurs (35).

(35) $[\![\text{IMPF}]\!] = \lambda P_{<l,<s,t>>} \lambda t_i \lambda w_s \exists e_l [t \subseteq \text{time}(e) \ \& \ P(e)(w)]$

We will also assume a null present tense $\emptyset$ (Matthewson and Silva 2007) with a denotation that makes the UT i_c a subinterval of the RT *t* (36).

(36) $[\![\text{PRES}]\!] = \lambda Q_{<i,<s,t>>} \lambda w_s \exists t_i [t \supseteq t_c \ \& \ Q(t)(w)]$

Finally, assuming a denotation for *nit-o'tsisi* as smoke(I) of type $\langle l,\langle s,t\rangle\rangle$ and a simplified syntactic structure where *nit-o'tsisi* composes first with IMPF and then the result composes with PRES, we have the semantic derivation of (1/33) in (37).

[13] In semantic denotations the following conventions are used: *w* is a variable over worlds, *t* is a variable over intervals of time and *e* is a variable over events; *s* is the type of worlds, *i* is the type of intervals, *e* is the type of events and *t* is the type of truth-values.

(37) $[\![$nit-o'tsisi$]\!] = \lambda e_l \lambda w_s$[smoke(I)(e)(w)]
$[\![$nit-á-o'tsisi$]\!] = [\![$IMPF$]\!]([\![$nit-o'tsisi$]\!])$
$= \lambda P \lambda t \lambda w \exists e[t \subseteq$ time(e) & P(e)(w)$](\lambda e \lambda w$[smoke(I)(e)(w)$])$
$= \lambda t \lambda w \exists e[t \subseteq$ time(e) & smoke(I)(e)(w)$]$
$[\![$nit-∅-á-o'tsisi$]\!] = [\![$PRES$]\!](\lambda t \lambda w \exists e[t \subseteq$ time(e) & smoke(I)(e)(w)$])$
$= \lambda Q \lambda w \exists t[t \supseteq t_c$ & Q(t)(w)$](\lambda t \lambda w \exists e[t \subseteq$ time(e) & smoke(I)(e)(w)$])$
$= \lambda w \exists t[t \supseteq t_c$ & $\exists e[t \subseteq$ time(e) & smoke(I)(e)(w)$]]$

(37) asserts the existence of a RT (t) that is a superinterval of the UT (t_c) and is also a subinterval of the runtime of an event of the speaker smoking (*time(e)*). While this is a reasonable formulation of the in-progress reading, it fails to capture the habitual reading where the RT is to be viewed as an interval characterized by events of the speaker smoking but is not necessarily to be viewed as a subinterval of a smoking event.

It is this failing of what we might call the neo-Reichenbachian analysis that the analysis of Bonomi (1997) is intended to remedy in the case of Italian and which is used to the same effect in this paper in the case of Blackfoot.

3 Bonomi's unification in Italian

Bonomi (1997) observes that verbs in the Italian *imperfetto* are ambiguous between an in-progress and a habitual interpretation. He argues that this ambiguity can be captured with a single denotation for the imperfetto and that factors external to the denotations of the aspectual elements—primarily the duration of the RT—are responsible for the ambiguity. Here I present an overview of what I consider to be the pertinent parts of the analysis of Bonomi (1997) as well as what I consider to be some necessary extensions and clarifications.

3.1 The puzzle Bonomi (1997) presents

In Italian, when a when-construction contains a perfective verb in the when-clause and an imperfective (i.e., imperfetto) verb in the main clause, it is possible to get both in-progress and habitual readings. That is, either one may understand the main clause event to be in-progress at the time of the when-clause event or one may view the main clause event as characterizing an interval in which the when-clause event occurs (38).

(38) *Quando fu notato da Miles Davis, Ahmad*
quando **fu** **nota-to** da Miles Davis, Ahmad
when **be.PAST.PERF** **notice.PAST.PART** by Miles Davis, Ahmad
Jamal suonava in un trio
Jamal **suona-va** in un trio
Jamal **play-PAST.IMPF** in a trio
'When Ahmad Jamal was noticed by Miles Davis, he was playing in a trio'
'When Ahmad Jamal was noticed by Miles Davis, he was a member of a trio'
(Bonomi 1997, p. 491)

However, Bonomi (1997) further observes that real world knowledge can exclude one of the readings. In (39), the *apnea record*—an underwater diving event—is incompatible with simultaneous smoking and the in-progress reading is therefore not available.

(39) *Quando batté il primato di apnea, Leo*
quando **batt-é** il primato di apnea, Leo
when **break-PAST.PERF** the record of apnea, Leo
fumava
fuma-va
smoke-PAST.IMPF
#'When Leo broke the apnea record, he was smoking'
'When Leo broke the apnea record, he was a smoker'
(Bonomi 1997, p. 490)

Interestingly, Bonomi notes that one of the readings of a sentence like (38) may be favoured depending on how long one understands the interval containing the events in the when-construction to be. If this interval, which he calls the "frame interval" (Bonomi 1997, p. 493-4), has a relatively long duration, then the habitual reading is favoured. If, on the other hand, the frame interval is short in duration, the in-progress reading is favoured. Although he gives no evidence for the latter, Bonomi claims that the understood duration of the frame interval may be a function either of context or of overt linguistic expression.

The fact that changing the duration of the frame interval can affect the meaning of (38) by causing a particular reading to be preferred, suggests that the imperfetto is not ambiguous in the sense of having two distinct denotations but that it has a single denotation that via semantic composition leads to a denotation for the entire sentence that is sometimes vague enough to allow both in-progress and habitual interpretations.

3.2 Bonomi's formalism

In the following subsections I discuss the crucial ingredients of Bonomi's analysis. These are (3.2.1) the proliferation of when-clauses, (3.2.2) the scope ambiguity between WHEN and aspect markers, (3.2.3) the denotations of IMPF and PERF and (3.2.4) the type-shifting of e-abstracts.

3.2.1 When-clauses everywhere

It is important to understand that in Bonomi's analysis a monoclausal sentence is treated as though it were a main clause in a when-construction. That is, if not explicit, an implicit and contextually determined when-clause is assumed to be present.[14] This means that a sentence like (3) actually has a structure similar to that in (38) above, as shown in (40) where the English text in small caps represents the implicit when-clause.

[14]The implicit when-clause is implicitly assumed (by Bonomi (1997) to have perfective aspect

(40) *Leo giocava a golf (*WHEN AN EVENT OCCURRED*)*
Leo gioca-**va** a golf (WHEN AN EVENT OCCURRED)
Leo play-**PAST.IMPF** PREP golf (WHEN AN EVENT OCCURRED)
'Leo used to play golf (WHEN AN EVENT OCCURRED)' (HABITUAL)
'Leo was playing golf (WHEN AN EVENT OCCURRED)' (IN-PROGRESS)

For Bonomi, when-constructions, i.e., structures of the form [WHEN(X)](Y) (where WHEN is the operator denoted by 'when' in English and 'quando' in Italian), serve to put the two events denoted by the *e-abstracts* (i.e., lambda abstractions on events[15]) X and Y in a relation of temporal coincidence. The meaning of this relation, symbolized by '><' in the following formulae, is purposefully left vague by Bonomi (1997). Although I will not discuss the matter in great detail here (but see (60) below where a specific formulation is proposed), ><(*e*, *e'*) can for now be roughly understood as meaning that events *e* and *e'* (a) have some temporal overlap or (b) are temporally contiguous. This is in contrast with other temporal conjuncts such as *after* and *before* (and their Italian equivalents), which would presumably denote different, non-overlap relations between events.

The denotation of WHEN is as in (41),[16] where C is the characteristic function of events that coincide with *e*, i.e., C(*e'*) means that event *e'* coincides with event *e*[17]. The introduction of C (as well as the universal quantification on events e'), although it may render the denotation of WHEN somewhat opaque, appears to be necessary in allowing Bonomi to build a compositional analysis of imperfective and perfective constructions as universal and existential quantifications over events respectively (see Bonomi (1997, p. 483) (esp. footnote 20) and below).

(41) $[\![\text{WHEN}]\!] = \lambda X \lambda Y \lambda e \lambda C[X(e) \wedge \forall e'[C(e') \leftrightarrow Y(e') \wedge >\!<(e, e')]]$
type: $<<e,t>,<<e,t>,<e,<e,t>>>>$

The reason that a more transparent denotation for WHEN is not available to Bonomi (1997) will now be explained. The problem essentially boils down to the fact that the existential quantifier takes scope over *coordinations* of expressions containing its

[15]For example, the denotation of Leo SMOKE (where SMOKE is to be understood as an intransitive verb composed semantically via function application (FA) with its subject argument but not with tense or aspect) is the e-abstract λe[leo-smoke(e)], which itself is shorthand for a Neo-Davidsonian λe[smoke(e) $\wedge$ AG(e, leo)]. The use of e-abstracts enables us to speak of events in a general way without reference to their times of occurrence with respect to the time of speech (i.e., tense) or their internal temporal constituency with respect to another salient interval (i.e., aspect). That is, e-abstracts allow us to refer, for example, to events of Leo smoking without confining ourselves to past, present or future tokens of such types of events. The e-abstract is a useful construct for the Bonomian analysis since it permits us to quantify over events while defining the restrictor of the quantificational statement with reference to tenseless and aspectless event types, i.e., e-abstracts.

[16]I have superficially altered Bonomi's denotations to make them amenable to a compositional analysis where syntactic trees are always binary-branching and never ternary-branching. This renders semantic compositionality more transparent.

[17]The coincidence function C(x) is in fact a binary function C(x)(y). While Bonomi (1997) does not state this explicitly, it is clear from his discussion that in order for C to be a general function that takes any event *e* and returns all coincidental events *e'*, C must first compose with *e*. In the interests of type simplicity, I follow Bonomi in writing C(*e'*) instead of C(*e*)(*e'*) even though the latter is technically correct. I see no reason why this simplification for expository purposes should pose any fatal problem for the analysis.

bound variable while the universal quantifier takes scope over expressions containing its bound variable which are in a *material conditional* or *if/then* structure.

Let us assume a *prima facie* reasonable (and simpler) denotation for WHEN (42) which employs neither the coincidence function C nor universal quantification over events.

(42) $[\![\text{WHEN'}]\!] = \lambda X \lambda Y \lambda e \lambda e'[X(e) \wedge Y(e') \wedge >\!<(e, e')]$
type: $<<e,t>,<<e,t>,<e,<e,t>>>>$

Now, the intuition of Bonomi (1997) is that perfective aspect should (a) introduce an interval *t*, (b) compose with the semantic entity that results when WHEN has been saturated by two e-abstracts and crucially (c) assert the existence of two events located within *t*. Given this intuition, a plausible denotation for the perfective might be (43).

(43) $[\![\text{PERF'}]\!] = \lambda W \lambda t \exists e \exists e'[e \subseteq t \wedge W(e)(e')]$
type: $<<e,<e,t>>,<i,t>>$

It is not a problem for (43) to take (42) as argument. A problem does arise, however, when we try to define the denotation of the imperfective in terms of universal quantification. Bonomi (1997) argues that imperfective aspect ought to (a) introduce an interval *t*, (b) compose with the semantic entity that results when WHEN has been saturated by two e-abstracts and crucially (c) assert that for every token of a certain type of event there is a coinciding token of a different type of event. Consider the potential denotation for imperfective in (44).

(44) $[\![\text{IMPF'}]\!] = \lambda W \lambda t \forall e \forall e'[e \subseteq t \wedge W(e) \rightarrow W(e')]$
type: $<<e,<e,t>>,<i,t>>$

The problem is that the coordinative structure built into the definition of WHEN' is perfect for the existential quantification of PERF' but incompatible with the universal quantification of IMPF'. In IMPF', W is a binary function that is only given one argument. This is a problem. What if we try to fix it by constructing IMPF' so that W is given two arguments, as in (45) or (45)?

(45) $[\![\text{IMPF''}]\!] = \lambda W \lambda t \forall e \forall e'[e \subseteq t \wedge W(e)(e') \rightarrow W(e)(e')]$

(46) $[\![\text{IMPF'''}]\!] = \lambda W \lambda t \forall e \forall e'[e \subseteq t \wedge W(e)(e') \rightarrow W(e')(e)]$

This resolves the type mismatch but, as the reader may easily verify, will not give us the denotation we desire.

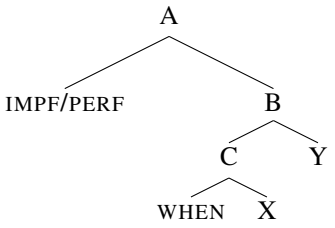
3.2.2 A scope ambiguity

From the denotations of WHEN and IMPF/PERF discussed so far, the types posited suggest that the aspectual operators consistently take wide scope over WHEN, i.e., the former compose via (FA) with the result of composing the latter with two e-abstracts.

However, Bonomi (1997) argues that the reverse scope—WHEN taking wide scope over the aspectual operators—is also possible in Italian.[18]

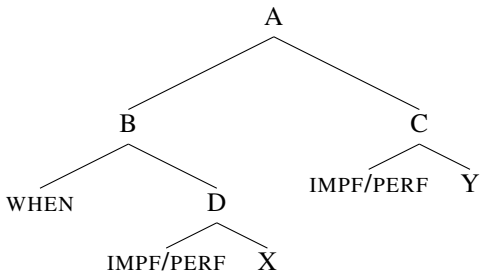
If the aspectual operators are identical across both clauses in a when-construction (i.e., if there is either imperfective aspect in both clauses or perfective in both clauses), the form is syntactically ambiguous. The LF structure may be one in which aspect takes wide scope as in (47).[19]

(47)



A form with matching aspect markers across clauses may also have a LF structure where aspect takes narrow scope as in (48).

(48)



In contrast, forms with mismatching aspect markers (e.g., a perfective in the when-clause and an imperfective in the main clause) are not syntactically ambiguous. Such forms may only have the LF structure where aspect takes narrow scope as in (48)

Focussing solely on forms with imperfective aspect in the main clause, we have three LF possibilities: (1) IMPF in both clauses and LF (47); (2) IMPF in both clauses and LF (48); and (3) IMPF in the main clause, PERF in the when-clause and LF (48). As will be shown below, each of these possibilities corresponds to a different semantic interpretation.

3.2.3 Defining imperfectivity and perfectivity

Bonomi (1997) posits the following denotation for IMPF.

(49) $[\![\text{IMPF}]\!] = \lambda\psi\lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge \exists C[\psi(e)(C)] \rightarrow \exists C[\psi(e)(C) \wedge C \neq \emptyset]]$
type: $<< e, < e, t >>, < i, t >>$

[18] Just how this is effected, i.e., considering the type mismatch that this ordering of semantic composition would entail, is discussed below.

[19] This means that a form that appears to contain two, say, imperfective morphemes on the surface may actually only contain one at LF

Here Cont() is a characteristic function of contextually relevant events.[20] While much of the denotation is opaque (once again this results from the demands of compositionality and the necessity of a when-construction having a denotation that can be both universally and existentially quantified over), the crucial elements are the universal quantifier and the introduction of an interval *t* and its superset relation to all events *e*. The intuition behind the denotation in (49) is that imperfective aspect acts like a universal adverb of quantification taking one e-abstract as its restrictor and another as its nuclear scope. The details of how the habitual and in-progress readings are thereby generated are discussed in subsection 3.3.

The interval *t* in (49) can be viewed as the analog of the RT in a Reichenbachian system insofar as it is ordered with respect to the UT when tense is brought into the mix. It should therefore be noted that Bonomi's analysis—where the RT is a *superinterval* of all events *e*—is in stark contrast to the analyses of Klein (1994) and Kratzer (1998) where the opposite relation is taken as characteristic of imperfectivity—i.e., RT is a *subinterval* of the runtime of an event.

The denotation of PERF is given in (50).

(50) $[\![\text{PERF}]\!] = \lambda\psi\lambda\text{t}\exists\text{e}[\subseteq(\text{e, t}) \wedge \exists\text{C}[\psi(\text{e})(\text{C}) \wedge \text{C}\neq\emptyset]]$
type: $<< e, < e, t >>, < i, t >>$

The intuition behind the denotation in (50) is that perfective aspect acts like an existential adverb of quantification and asserts the existence of an event whose runtime is a subinterval of *t*. Again, the details of how this denotation generates the attested readings is discussed in subsection 3.3.

In terms of type compatibility, IMPF/PERF can take as argument the result of composing WHEN with two e-abstracts. This explains how structure (47) is semantically well-formed.

Conversely, WHEN can take as argument the result of composing IMPF/PERF with an e-abstract. This explains how structure (48) is semantically well-formed. This order of composition is possible for two reasons: first, a type-shifting rule (discussed in subsection 3.2.4 below) can shift e-abstracts to type $< t, < e, t >>$; second, intervals and events are treated as interchangeable by Bonomi (1997), which, in this case, means that WHEN may take arguments of either type $< i, t >$ or $< e, t >$.[21]

3.2.4 Typeshifting e-abstracts

As mentioned above, a problem with the structure in (48) is that e-abstracts do not have the right type needed to compose with IMPF or PERF via FA. As the aspectual

[20] Cont() would be used to account, for example, for the fact that in a sentence like *Whenever the janitor saw me he opened the door* events of the janitor seeing me walking away from the building would not be considered relevant "triggers" for his opening of the door. Just how the denotation of Cont() is to be determined is left as an open problem by Bonomi (1997).

[21] Bonomi (1997) treats the set *I* of intervals as a subset of the set *E* of events (Bonomi 1997, p. 480) and thus freely talks about events themselves coinciding or being in other temporal relations with intervals or other events. Those uncomfortable with a system that treats event and intervals on a par might prefer to speak of the "runtimes" of events coinciding rather than the events themselves. Whether his conflation of events and intervals is ultimately fatal to Bonomi's analysis is a question I leave for future research.

denotations in (49, 50) indicate, Bonomi's aspectual operators are designed to compose with the output of a when-construction. However, we will remember that Bonomi (1997) conceives of monoclausal structures as containing implicit when-clauses which situate the event denoted by the clause as coinciding with a contextually salient event. This situating of an event with respect to a contextually salient event is essentially what Bonomi (1997) is doing when he type-shifts e-abstracts from type $< e, t >$ to type $< i, < e, t >>$, only in the type-shifting case the event is situated with respect to a contextually salient interval *t*.[22]

(51) TYPE-SHIFTING RULE Bonomi (1997, p. 487)
↑A = λtλC∀e[C(e) ↔ A(e) ∧ ><(t, e)]
where A is an e-abstract

3.3 Solving the puzzle in Italian

Having described the primary ingredients of Bonomi's analysis, I now show how it correctly generates the attested interpretations for the Italian forms. I will focus on two types of constructions in the following order: first, when-constructions that have imperfectives in both clauses and in which aspect takes wide scope over WHEN at LF (cf. the structure in (47)); second, when-constructions that have an imperfective in the main clause and either an implicit when-clause or a when-clause containing perfective aspect—in this latter type of case, as we have seen, only the LF where aspect has narrow scope is possible (cf. the structure in (48)).

3.3.1 Wide-scope constructions

Consider the Italian sentence in (52). This form is ambiguous between two habitual-type readings. The English translation in the first row is intended to represent the interpretation where each past event of Leo playing golf within a given interval coincides with an event of Leo making a lot of money within that same interval. We will call this reading the *whenever* reading. The second English translation represents the interpretation where intervals rather than events are described as coinciding. The two intervals are characterized by different events: in this case, one by golf-playing events and the other by money-making events. We will call this reading the *coinciding-habitual-intervals* reading or *CHI* for short. The CHI reading is a function of the LF structure where aspect takes narrow scope with respect to WHEN.[23] In this section, however, we concern ourselves with Bonomi's account of the whenever interpretation where aspect takes wide scope with respect to WHEN.

(52)	*Quando*	*giocava*	*a*	*golf,*	*Leo*	*guadagnava*	*molto*
	quando	**gioca-va**	a	golf,	Leo	**guadagna-va**	molto
	when	**play-PAST.IMPF**	at	golf,	Leo	**win-PAST.IMPF**	much

[22] Recall that Bonomi (1997) treats events and intervals on a par. Note also that the expression Cont(*t*) should also be present in the above formula (i.e., it should read ↑A = λtλC[Cont(t) ∧ ∀e[C(e) ↔ A(e) ∧ ><(t, e)]]) in order to express that the interval *t* (with which all events *e* coincide) is a contextually relevant one. In hopes of making the derivation more readable, I follow Bonomi in omitting this expression

[23] For reasons of space I do not discuss when-constructions that have imperfectives in both clauses *and* in which aspect takes narrow scope. I refer the interested reader to Bonomi (1997).

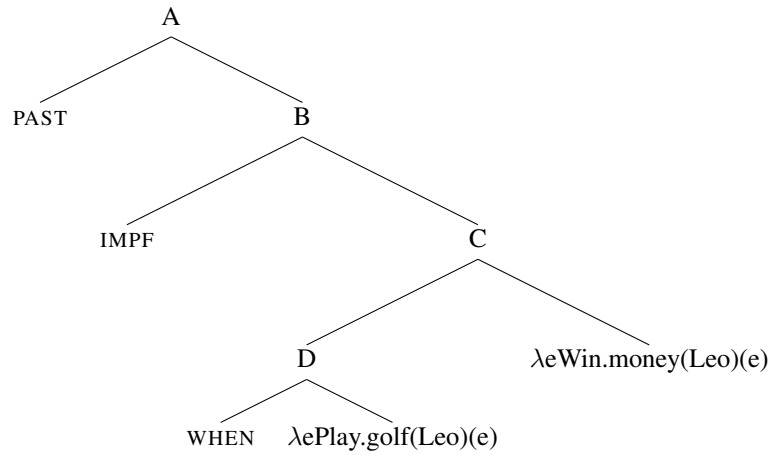
'Whenever he played golf, Leo made a lot of money'

'When he played golf, Leo made a lot of money'

Bonomi (1997, p. 486)

Form (52) has (53) as a possible LF structure .

(53)



Given the denotations of WHEN and IMPF above as well as a simplified denotation for PAST,[24] the resultant denotation of (53) is (54). (A complete derivation is given in Appendix A.)

(54) $[\![(53)]\!] = \exists t[<(t, t_c) \wedge \forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge$
Play.golf(Leo)(e) $\rightarrow \exists e'[\text{Win.money(Leo)}(e') \wedge ><(e, e')]]]$

Denotation (54) may be paraphrased as follows: *there is an interval t before the time of utterance t_c such that for all events e that are included in t and are contextually relevant events of Leo playing golf there is an event e' that coincides with e and is an event of Leo earning money*. This denotation captures the whenever reading of (52) discussed above.

Although (52) is ambiguous, its ambiguity is between two types of habitual readings (whenever and CHI). In the next section I show how Bonomi's analysis accounts for sentences that are ambiguous between a habitual and an in-progress reading.

3.3.2 Narrow-scope constructions

Consider again sentence (38) repeated below as (55).

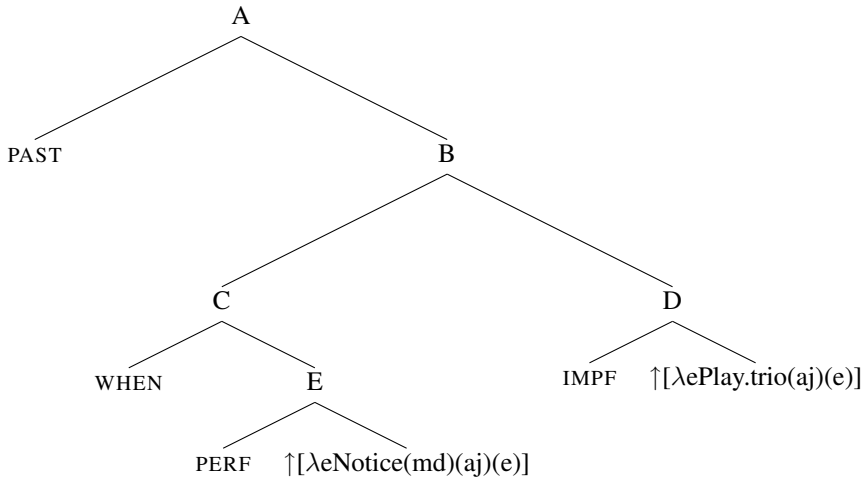
[24] Following Bonomi (1997), I provisionally assume a simplified analysis of past tense which functions to existentially quantify over an RT interval *t* and order it before the UT interval t_c:

1. $[\![\text{PAST}]\!] = \lambda W \exists t[<(t, t_c) \wedge W(t)]$
   type: $<< i, t >, t >$

(55) *Quando fu notato da Miles Davis, Ahmad*
quando **fu** **nota-to** da Miles Davis, Ahmad
when **be.PAST.PERF** **notice.PAST.PART** by Miles Davis, Ahmad
Jamal suonava in un trio
Jamal **suona-va** in un trio
Jamal **play-PAST.IMPF** in a trio
'When Ahmad Jamal was noticed by Miles Davis, he was playing in a trio'
'When Ahmad Jamal was noticed by Miles Davis, he was a member of a trio'

Since the when-clause contains perfective aspect and the main clause imperfective aspect, (55) must have structure (56).

(56)



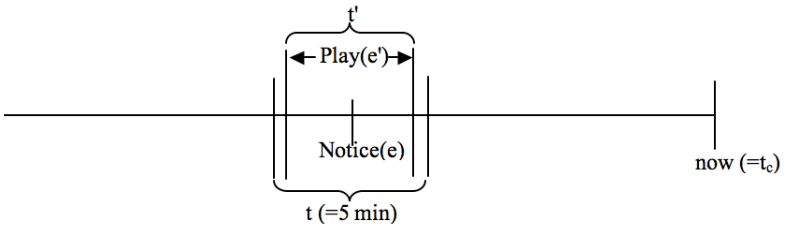
The denotation of (56) is given in (57). (The full derivation is in Appendix B.)

(57) $[\![(56)]\!] = \exists t[<(t, t_c) \wedge \exists e[\subseteq(e, t) \wedge \text{Notice(md)(aj)(e)}] \wedge$
$\forall t'[\subseteq(t', t) \wedge \text{Cont}(t') \rightarrow \exists e'[\text{Play.trio(aj)}(e') \wedge ><(t', e')]]]$

Denotation (57) may be paraphrased as follows. *There is a RT t before the UT t_c and there is an event e of Miles Davis noticing Ahmad Jamal whose runtime is a subinterval of t and all contextually relevant subintervals t' of t coincide with an event e' of Ahmad Jamal playing in a trio.* How the habitual/ in-progress ambiguity arises from (57) is more easily understood with the help of graphical representations.

We will first consider the case where the the RT is understood to be a short[25] interval. This state of affairs is depicted in (58).

[25]While *short* and *long* are clearly vague predicates, the ellipsis here is *relative to the typical duration of the events under discussion*.



(58)

Representation (58) depicts a scenario where context provides a short RT *t*: a five minute interval. (57) asserts that all contextually relevant subintervals *t'* of *t* coincide with an event *e'* of Ahmad Jamal playing in a trio. In order to avoid vacuous quantification, i.e., in order to avoid the interpretation where there are no relevant subintervals *t'* of *t*, I appeal to a general prohibition against vacuous quantification following Kratzer (1995) and Chomsky (1982). This allows us to assume that there is at least one relevant interval *t'* in *t* that coincides with an event of playing in a trio.

Let us assume that real-world knowledge supplies the information that trio-playing events generally last longer than five minutes. Let us also assume, provisionally this time, that *coincides with* denotes the exact overlap function on two temporal entities, i.e., the function that returns true when its two arguments are intervals or events with identical duration and identical midpoints. Given at least one interval *t'* that is a subinterval of a five-minute RT *t* and which exactly overlaps with the runtime of a trio-playing event *e'* (a token of a type of event that typically lasts more than five minutes), the best conclusion, i.e., the one that best satisfies the constraint of non-vacuous quantification and real-world trio-playing durations, is that there is *exactly* one maximally long interval *t'* within the RT *t* and hence exactly one maximally long trio-playing event *e'* within *t*.

Since, as we have just found, the optimal interpretation is one where a trio-playing event *e'* occupies as much of the RT *t* as possible and since, from (57), we know that there is a near-instantaneous[26] noticing event *e* within the RT, it is almost a certainty that *e'* is in the process of occurring while *e* occurs. This interpretation, which is what we have been calling the *in-progress* interpretation, is depicted graphically in (58).

Of course, the exact overlap denotation of coincidence was a provisional assumption. As discussed above, Bonomi (1997) wants $><$(*t'*, *e'*) to be vague enough to be satisfied by situations where *t'* and *e'* have just *some* overlap or are merely temporally contiguous. This means that (57) with an implicit five minute RT *t* is also compatible with an interpretation where the subinterval *t'* is located at one of the terminal ends of *t* and is temporally contiguous with a trio-playing event *e'* that is itself external to *t*. The resulting interpretation is (at best) one where the noticing event is contiguous with the playing event and (at worst) one where there is a five minute interval separating the end of one event and the beginning of the other. Obviously neither of these interpretations fit the criteria of the in-progress interpretation.

While Bonomi (1997) does not discuss this problem, a solution to it would be to say that $><(\alpha, \beta)$ actually does denote the exact overlap relation between α and β and that

[26]That noticing events are near-instantaneous is here understood as part of the speech act participants' real-world knowledge.

the non-exact overlap and temporal contiguity relations form a descending scale of accommodations forced by external factors. For example, (59) exemplifies a case where real-world knowledge of light-to-roach-scurrying causality forces the accommodation of $><(\alpha, \beta)$ to the temporal contiguity relation.[27]

(59) When Bill turned on the light, the roaches scurried under the fridge.

This new conception of the coincidence relation is formalized in (60).[28,29]

(60) $[\![><(\alpha, \beta)]\!] = 1$ *iff*

1. α and β are intervals or events AND
2. (a) α and β share the same midpoint and have identical duration
   ELSE IF (2A) IS NOT POSSIBLE:
   (b) α and β share the same midpoint
   ELSE IF (2B) IS NOT POSSIBLE:
   (c) α and β have some temporal overlap
   ELSE IF (2C) IS NOT POSSIBLE:
   (d) α and β are temporally contiguous

The revised denotation of the coincidence relation in (60) solves the problem described above as follows. The form in (55) with an implicit five minute RT will, following a similar argument to that given above, continue to (almost certainly) have an in-progress reading. If the real-world knowledge of the interpreter of (55) allows trio-playing events to be as short as five minutes, subclause (2a) of (60) will be satisfied and hence the trio-playing event will be understood as coinciding exactly with both *t* and the RT *t'* and hence the in-progress interpretation will fall out. If, on the other hand, real-world knowledge dictates that trio-playing events must be longer than five minutes, subclause (2b) of (60) will be satisfied and hence the trio-playing event will be understood as a superinterval of the RT *t* and the in-progress interpretation will still fall out. In the case of (59), real-world knowledge concerning the events in question will rule out the first three subclauses of (60) and satisfaction of subclause (2d) will be the only way of satisfying (60) as a whole. The result will be that the illuminating and scurrying events will be interpreted as non-overlapping but contiguous.

The conclusions reached above are quite general. The shorter the RT relative to the events in the when-construction, the more likely the in-progress interpretation. As we will see, the converse state of affairs holds with a longer RT: the in-progress interpretation becomes increasingly unlikely.

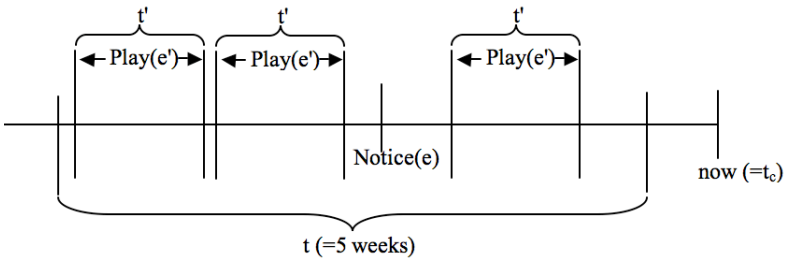
[27] Another solution to the problem would be to say that it is not a problem at all since the interpretation is in fact compatible with (55). That is, it is an empirical question whether *Quando fu notato da Miles Davis, Ahmad Jamal suonava in un trio* is compatible with an interpretation where the noticing occurs and then five minutes later the playing begins. My suspicion, however, is that it is not.

[28] The relation of sharing the same midpoint is general enough to capture both exact overlap between intervals of identical duration and a plausible notion of exact overlap between intervals of different durations wherein the shorter interval is located in the exact middle of the longer interval.

[29] It is possible that a sufficient denotation for this gradiently conceived coincidence relation would require an Optimality Theory-like approach that makes use of a ranking of violable constraints. I leave this possibility to future research.

Consider the case where the the RT is understood to be a long interval, say a five-week interval as depicted in (61).

(61)



Now, five weeks is longer than any typical event of playing in a trio. From (57) and the definition of coincidence in (60), we know that all relevant subintervals *t'* of *t* overlap exactly with a trio-playing event *e'*.[30] Let us make the following plausible assumptions about real-world speaker and hearer knowledge: (a) a typical trio-playing event lasts exactly two hours on average and (b) nobody plays in a trio more than two times per day. This means that of the 840 hours in the RT *t* of (61), only 140 are possible trio-playing hours, which means that a given near-instantaneous noticing event *e* within *t* will have only a one in six chance of temporally overlapping with a playing event.

The above-described scenario, where within a five-week interval there are multiple trio-playing events that occur regularly at the relevant intervals (i.e., intervals where Ahmad Jamal is so disposed and the trio-playing conditions are right) and there is a single noticing event that is unlikely to overlap with any of the playing events, seems to adequately capture the habitual interpretation.

We have now seen that as a general rule when the RT increases in duration the in-progress reading becomes less and less likely. This claim is, in fact, the essence of Bonomi's analysis.

3.3.3 The primacy of habituality

We have just seen that by the logic of the Bonomian system, an increase in the duration of the RT means a decrease in the likelihood of an in-progress interpretation. It is interesting to note, however, that nothing in the analysis licenses the converse generalization with respect to the habitual interpretation. That is, it is not the case that as the RT increases in duration the habitual reading becomes more and more likely. What this means is that there is a sense in which, for Bonomi (1997), the habitual reading is always present with imperfective aspect. To see what I mean, let us assume the following plausible criterion for habitual meaning.

(62) A denotation D is habitual iff it is of the form
$\forall x[P(x) \rightarrow \exists y[Q(y) \wedge >\!<(x, y)]]$

[30] In other words, there is nothing to prevent the strongest version of the coincidence relation (the exact overlap relation) from holding.

(where x and y are events or intervals and P and Q are e/i-abstracts (i.e., sets of events or intervals))

Definition (62) effectively means that a habitual interpretation arises whenever we assert that a certain type of event always occurs at a relevant interval and this is exactly what the denotation of IMPF in (49) does. As a result of the definition of IMPF given in Bonomi (1997), an expression of the form in (62) is present in the third conjunct of the denotation given in (57) above. Thus, even when *Quando fu notato da Miles Davis, Ahmad Jamal suonava in un trio* is interpreted in the context of a relatively short interval and the in-progress interpretation is preferred, it is true that the token of a playing in a trio event is characteristic of the five minute interval discussed above in a way that is qualitatively no different from the way that the same type of event is characteristic of the five week interval also discussed above. This primacy of the habitual interpretation illustrates another way in which the analysis of Bonomi (1997) differs from that of Klein (1994) and Kratzer (1998), in whose analyses the in-progress interpretation is not only primary but solitary.

It might appear that the analysis of Bonomi (1997) runs into a problem in that it becomes impossible to distinguish between an event that occurs only once in the course of the five-week RT but is still understood as characteristic of that RT from an event that similarly occurs only once but is not understood as characteristic. However, I would suggest that such a distinction is never, in practice, made. That is, I will claim that whenever an event is denoted by a predicate with imperfective aspect, that event is to be understood as characteristic of an implicit RT.

Although it may appear strange at first, I do not see any substantive objection to an analysis that treats on a par both short intervals that are subintervals of the runtime of a single event and long intervals that are superintervals of the runtimes of multiple tokens of an event type. I suggest that such an identification makes dialogues such as (63) possible.

(63) ALFRED: Are you a smoker Charles?
CHARLES: Nope.
ALFRED: Really? I thought you were. I saw you smoking yesterday.
CHARLES: Oh, that was the first time I ever smoked. I didn't like it much.
Though, I guess you could say that *for five minutes I was a smoker*.

Under the analysis proposed here, the italicized portion of Charles' response is not anomalous. In effect, what he is saying to Alfred is *The point at which you saw me smoking was a subinterval of a five minute interval that could be viewed as characterized by my smoking.*

Now that we have seen how the analysis of Bonomi (1997) proposes to account for in-progress and habitual readings of imperfective forms, we are in a position to consider how the model handles parallel cases in Blackfoot.

4 A Bonomian account of Blackfoot *Á-*

Application of Bonomi's analysis to the morpheme *á-* in Blackfoot is somewhat complicated by the fact that *á-*prefixed forms can be interpreted as referring to either past or

present in-progress or habitual events.[31] In what follows I assume, following Matthewson and Silva (2007), that Blackfoot has phonologically null present and past morphemes that can covertly co-occur with *á-* and which facilitate the present/ past ambiguity of *á*-prefixed forms. I further assume a phonologically null perfective morpheme in a paradigmatic relationship with the imperfective *á-*.[32]

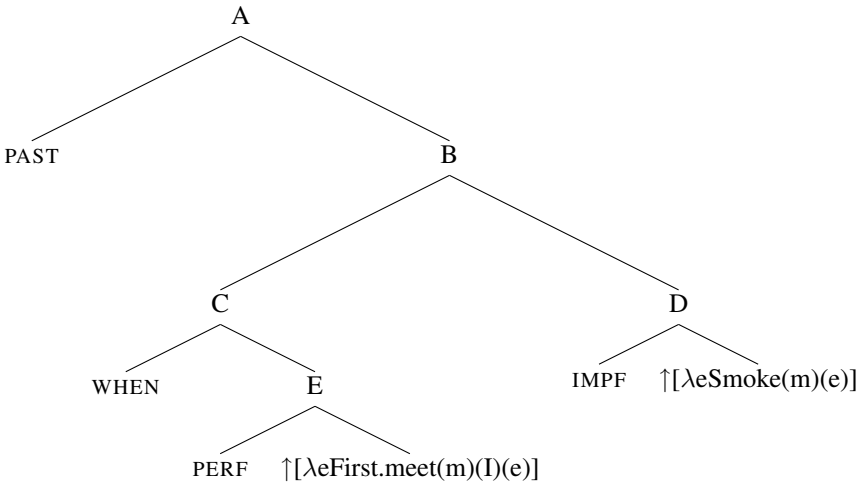
4.1 Past imperfective Blackfoot forms

Consider again (2) repeated as (64) below. This form is ambiguous between past in-progress and habitual readings in a way that exactly parallels the Italian form in (55).

(64) *nitáístsitso'tatsimasii* *annahk*
nit-**a**-∅-∅-isttsitsa-o'táaatsiim-aa-hsi ann-wa-hka
1-**when**-**PAST**-**PERF**-first.time-meet(vta)-DIR-CONJ DEM-PROX-INVS
Martina áótsisi
Martina ∅-**á**-o'tsisii
martina **PAST**-**IMPF**-smoke(vai)
'when I first met Martina, she was a smoker'
'when I first met Martina, she was smoking'

Again like (55), (64) has mismatching aspect across its clauses and therefore has as its sole possible LF structure that wherein WHEN takes wide scope with respect to aspect (65).

(65)



[31] One could also perhaps argue that the imperfective in Italian, and possibly in Romance in general, is deserving of the similar treatment. That is, that past imperfective morphology is a portmanteau for past tense and imperfective aspect while the present imperfective (more commonly labeled *simple present*) is a portmanteau for present tense and imperfective aspect. Further research is required to determine whether such a conception is truly portable to the Romance tense-aspect system(s).

[32] Whether the choice of a phonologically null perfective morpheme over default imperfective aspect is crucial or not is a question I cannot answer at this time.

The denotation of (65) is given in (66). (The full derivation is nearly identical to that given for (55) in Appendix B and so is not repeated there.)

(66) $[\![(65)]\!] = \exists t[<(t, t_c) \wedge \exists e[\subseteq(e, t) \wedge \text{First.meet(m)(I)(e)}] \wedge$
$\forall t'[\subseteq(t', t) \wedge \text{Cont}(t') \rightarrow \exists e'[\text{Smoke(m)}(e') \wedge ><(t', e')]]]$

Following arguments familiar from the above discussion, the in-progress and habitual readings attested for (64) are deducible from the denotation given in (66) and variable contextual specification of the duration of the RT *t*.

While example (2) contains an explicit when-clause with covert perfective morphology, a form with an implicit when-clause, such as (1) above, should have past in-progress and past habitual readings available as well. In fact, a past in-progress reading for (1) is easily obtained when context or a temporal adverbial situate the event in the past and, as we have seen, a past habitual reading is obtainable, given the appropriate context, from the structurally parallel form (12).

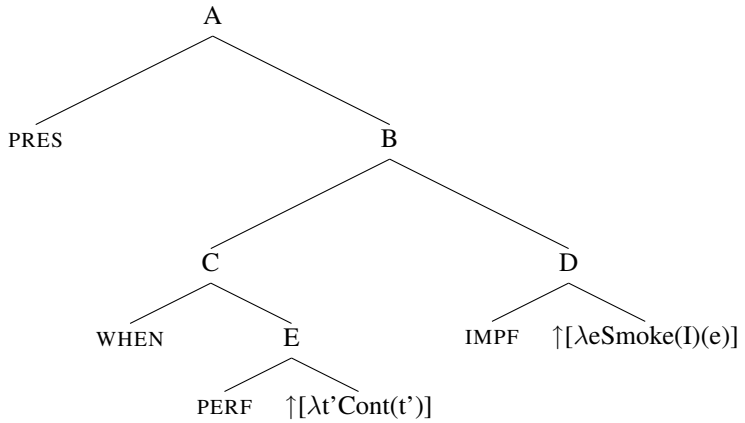
4.2 Present imperfective Blackfoot forms

Example (1), repeated here as (67), allows both present habitual and present in-progress readings.

(67) *nitáó'tsisi*
nit-∅-**á**-o'tsisii
1-**PRES**-**IMPF**-smoke(vai)
'I smoke' (HABITUAL)
'I am smoking' (IN-PROGRESS)

Following Bonomi (1997), I assume an implicit when-clause whose i-abstract is true of a contextually determined interval *t'* as illustrated in (68).

(68)



The denotation for (68) is in (69) and its derivation is in Appendix C.

(69) $[\![(68)]\!] = \exists t[\subseteq(t_c, t) \wedge \exists t'[\subseteq(t', t) \wedge \text{Cont}(t')] \wedge$
$\forall t''[\subseteq(t'', t) \wedge \text{Cont}(t'') \rightarrow \exists e[\text{Smoke(I)}(e) \wedge ><(t'', e)]]]$

Denotation (69) may be paraphrased as follows. *The UT t_c is a subinterval of a RT t and there is a contextually relevant$_1$ interval t' that is also a subinterval of t and all contextually relevant$_2$ subintervals t" of t coincide with events e of the speaker smoking.* Implicit here is the idea that intervals *t'* and *t"* must be "contextually relevant" in different ways: *t'* is the temporal analog of the event denoted by an explicit when-clause and its relevance is different from that of *t"* which is an interval that is relevant because it is just right for a smoking event by the speaker.

The account of the in-progress/ habitual ambiguity for present imperfective forms is not altogether dissimilar from that given above for past imperfective ones. Once again the overarching generalization is that as the RT *t* increases in duration relative to the events in question, the likelihood of an in-progress interpretation increases.

Let us assume, first of all, that the UT t_c is, in general, instantaneous.[33] In cases where the RT is taken also to be instantaneous (i.e., identical to the UT), the result is that the "when-clause" interval *t'* will also be identical to the UT and the smoking event *e* will, as a result of real-world knowledge of smoking event durations, at best satisfy subclause (2b) of the coincidence relation (60) and interval *t'* will to a certainty be a subinterval of the runtime of *e*, thus generating the in-progress reading.

In cases where the RT is taken to be a much longer interval (for example, a year in duration) interpretation of (67) will, following arguments that should by now be familiar, be habitual.

5 Summary

We have seen that the morpheme *á-* in Blackfoot shares many properties with morphemes/ constructions labeled imperfective in IE languages and that the analysis by Bonomi (1997) of the Italian past imperfective form can be applied to *á-*. In fact, this analysis is superior, I argue, to other existing semantic analyses of the imperfective (cf. Klein (1994); Kratzer (1998)) since it accounts for both the habitual and in-progress interpretations typical of imperfective forms. In the course of applying Bonomi's analysis to Blackfoot, I have shown (a) that it is applicable to a morpheme that can be used to express both past and present habitual and in-progress meaning and (b) that several components, in particular the denotation of the coincidence function, require a more explicit treatment than that given in Bonomi (1997).

5.1 PERF-PERF constructions

As a final note I will briefly discuss when-constructions with perfective morphology in both clauses. We have seen a Blackfoot token of such a construction in (25) repeated here as (70).

[33] Though I believe it plausible, I do not consider this assumption crucial to the analysis. It should also be noted that I am agnostic with regards to whether the linguistic system treats time as a discrete or as a continuous and without minimal intervals. If the former, we can understand "instantaneous" to mean "equal to a minimal interval" and if the latter, we can understand it to mean "shorter than some contextually determined threshold".

(70) *otát'ihpiyi'si* *anná* *John,* *anná* *Amelia* *iin'ihkít*
ot-**á'**-ihpiyi-hsi ann-wa John, ann-wa Amelia inihki
3-**when**-dance-CONJ DEM-PROX John DEM-PROX Amelia sing
'When John went up to dance, Amelia sang'
'When John was dancing, Amelia sang'

This example presents two puzzles. First is the use of the English progressive in the second offered translation. Second is the single-event/ habitual coinciding events ambiguity of the first offered translation. Although felicity judgments under carefully circumscribed contexts are required in order to really get at the meaning that the speaker is assigning to this form, we may as a first step ask how the analysis of Bonomi (1997) might account for the English translations.

In Bonomi's analysis, when-constructions with perfective morphology in both clauses are structurally ambiguous in the same way as such constructions with imperfective morphology in both clauses. That is, aspect may take wide or narrow scope with respect to *when*.

If we assume for the moment the structure where aspect takes wide scope, the denotation of (70) turns out to be as in (71) (a partial derivation is given in Appendix D).

(71) $[\![(70)]\!] = \exists t[<(t, t_c) \wedge \exists e[\subseteq(e, t) \wedge \text{Dance(John)}(e) \wedge$
$\exists e'[\text{Sing(Amelia)}(e') \wedge ><(e, e')]]]$

Given the definition of coincidence from (60) above, we should understand (71) to assert the existence of a past interval *t* in which occurs an event *e* of John dancing, which event identically overlaps with an event *e'* of Amelia singing. This is because there is nothing about real-world knowledge of dancing and singing events that prohibits subclause (2a) (i.e., identical midpoints and duration) of (60) from being true. This denotation is compatible with the first translation offered for (70), which may be understood to refer to a state of affairs where the event of John starting to dance and the event of Amelia starting to sing occur at the same instant.

Somewhat surprisingly, if we assume the structure where aspect takes narrow scope, the denotation of (70) is as in (72).

(72) $[\![(70)]\!] = \exists t[<(t, t_c) \wedge \exists e[\subseteq(e, t) \wedge \text{Dance(John)}(e)] \wedge$
$\exists e'[\subseteq(e', t) \wedge \text{Sing(Amelia)}(e')]]$

This denotation is notable in that it enforces only a very weak temporal relation between the two events, namely that of being sub-intervals of the RT *t*. This means that (70) should be felicitous in describing situations where the dancing and singing events are overlapping, contiguous or neither overlapping nor contiguous. Obviously so general a denotation correctly predicts the in-progress interpretation implied by the second offered translation. However, it also predicts interpretations—i.e., non-overlapping and non-contiguous ones—that might not be expected.

A further consequence of the denotations available to (70) is that habitual interpretations are not predicted. While this may be a true prediction for Blackfoot (further

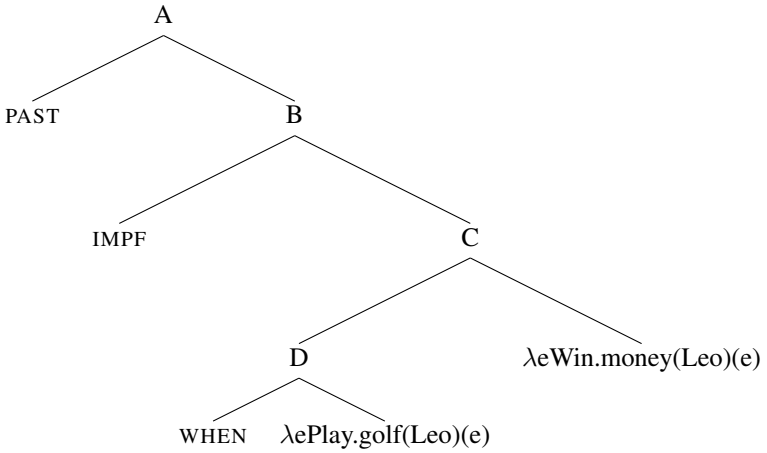
elicitation is required), it is certainly a false one for English where a sentence like *When John danced, Amelia sang* may in fact have a habitual reading. Perhaps this finding reveals the need for an implicit generic operator along the lines of Krifka et al. (1995) in order to generate habitual readings in constructions with perfectives in both clauses. Further work in this area is required.

Appendix A Derivation of (52)

Quando	*giocava*	*a*	*golf,*	*Leo*	*guadagnava*	*molto*
quando	**gioca-va**	a	golf,	Leo	**guadagna-va**	molto
when	**play-PAST.IMPF**	at	golf,	Leo	**win-PAST.IMPF**	much

'Whenever he played golf, Leo made a lot of money'

'When he played golf, Leo made a lot of money'



⟦**quando**⟧
= WHEN
= $\lambda X \lambda Y \lambda e \lambda C[X(e) \wedge \forall e'[C(e') \leftrightarrow Y(e') \wedge >\!<(e, e')]]$

⟦**giocava a golf**⟧
= λePlay.golf(Leo)(e)

⟦D⟧
= ⟦**quando**⟧(⟦**giocava a golf**⟧)
= $\lambda X \lambda Y \lambda e \lambda C[X(e) \wedge \forall e'[C(e') \leftrightarrow Y(e') \wedge >\!<(e, e')]](\lambda e$Play.golf(Leo)(e))
= $\lambda Y \lambda e \lambda C$[Play.golf(Leo)(e) $\wedge \forall e'[C(e') \leftrightarrow Y(e') \wedge >\!<(e, e')]]$

⟦**Leo guadagnava molto**⟧
= λeWin.money(Leo)(e)

⟦C⟧
= ⟦D⟧(⟦**Leo guadagnava molto**⟧)
= $\lambda Y \lambda e \lambda C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow Y(e') \wedge >\!<(e, e')]](\lambda e$Win.money(Leo)(e))
= $\lambda e \lambda C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow \text{Win.money(Leo)}(e') \wedge >\!<(e, e')]]$

⟦IMPF⟧

$= \lambda\psi\lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge \exists C[\psi(e)(C)] \rightarrow \exists C[\psi(e)(C) \wedge C{\neq}\emptyset]]$
(*imperfetto* morphology in both clauses signals possibility of IMPF with wide scope over WHEN)

$[\![B]\!]$
$= [\![\text{IMPF}]\!]([\![C]\!])$
$= \lambda\psi\lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge \exists C[\psi(e)(C)] \rightarrow \exists C[\psi(e)(C) \wedge C{\neq}\emptyset]]$
$(\lambda e\lambda C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow \text{Win.money(Leo)}(e') \wedge$
$><(e, e')]])$
$= \lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge$
$\exists C[\lambda e\lambda C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow \text{Win.money(Leo)}(e') \wedge$
$><(e, e')]](e)(C)] \rightarrow$
$\exists C[\lambda e\lambda C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow \text{Win.money(Leo)}(e') \wedge$
$><(e, e')]](e)(C) \wedge C{\neq}\emptyset]]$
$= \lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge$
$\exists C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow \text{Win.money(Leo)}(e') \wedge$
$><(e, e')]] \rightarrow$
$\exists C[\text{Play.golf(Leo)}(e) \wedge \forall e'[C(e') \leftrightarrow \text{Win.money(Leo)}(e') \wedge$
$><(e, e')] \wedge C{\neq}\emptyset]]$
$= \lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge \text{Play.golf(Leo)}(e) \rightarrow$
$\exists e'[\text{Win.money(Leo)}(e') \wedge ><(e, e')]]$

[The previous step in the derivation is explained as follows. The condition *∃C[Play.golf(Leo)(e) ∧ ∀e'[C(e') ↔ Win.money(Leo)(e') ∧ ><(e, e')]]* is always (vacuously) true since for every event *e* there is a set *C* of events *e'* that temporally coincide with *e*—often *C* is the empty set ∅. Since the condition is trivially true, the consequence *∃C[Play.golf(Leo)(e) ∧ ∀e'[C(e') ↔ Win.money(Leo)(e') ∧ ><(e, e')] ∧ C≠∅]]* holds. The consequence is identical to the condition except that it ensures that *C* is not the empty set, i.e., it assures us that there is a nonempty set *C* of events *e'* that coincide with *e* (and which fulfill the other condition, namely being events of Leo earning money) (see Bonomi (1997, p. 483, footnote 20)).

Finally, asserting *∃C[Play.golf(Leo)(e) ∧ ∀e'[C(e') ↔ Win.money(Leo)(e') ∧ ><(e, e')] ∧ C≠∅]]* within the scope of a universal quantification over *e* is equivalent to asserting that for any event *e* there is at least one event *e'* that is a Leo-earn-money event which coincides with *e* (remember that *C(e')* is shorthand for *C(e)(e')* which means *e'* coincides with *e*). But this last equivalence is the same as saying *Play.golf(Leo)(e) → ∃e'[Win.money(Leo)(e') ∧ ><(e, e')]*. So we have our result.]

$[\![\text{PAST}]\!]$
$= \lambda W{\in}D_{<i,t>}\exists t[<(t, t_c) \wedge W(t)]$
$[\![A]\!]$
$= [\![\text{PAST}]\!]([\![B]\!])$
$= \lambda W{\in}D_{<i,t>}\exists t[<(t, t_c) \wedge W(t)]$
$(\lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge \text{Play.golf(Leo)}(e) \rightarrow$
$\exists e'[\text{Win.money(Leo)}(e') \wedge ><(e, e')]])$
$= \exists t[<(t, t_c) \wedge$
$\lambda t\forall e[\subseteq(e, t) \wedge \text{Cont}(e) \wedge \text{Play.golf(Leo)}(e) \rightarrow$

$\exists$e'[Win.money(Leo)(e') $\wedge$ ><(e, e')]](t)]
= $\exists$t[<(t, t_c) $\wedge$
$\forall$e[$\subseteq$(e, t) $\wedge$ Cont(e) $\wedge$ Play.golf(Leo)(e) $\rightarrow$
$\exists$e'[Win.money(Leo)(e') $\wedge$ ><(e, e')]]]

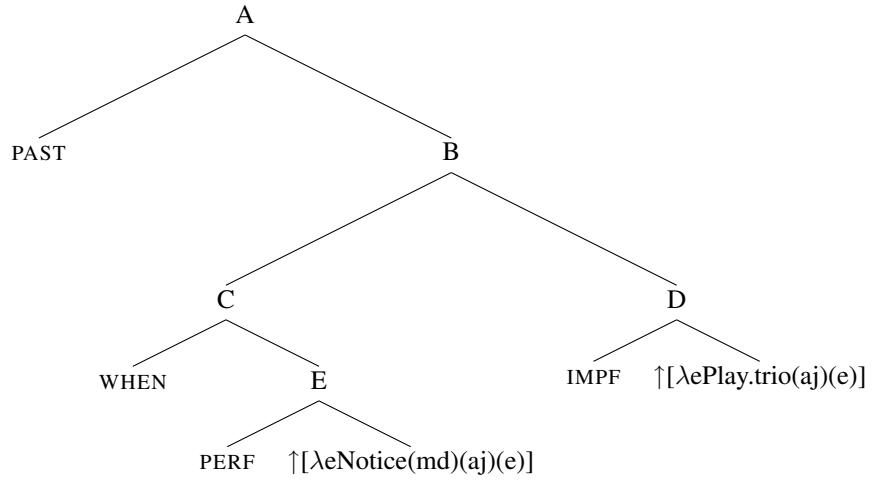
Appendix B Derivation of (55)

Quando	*fu*	*notato*	*da*	*Miles*	*Davis,*	*Ahmad*	*Jamal*
quando	**fu**	**nota-to**	da	Miles	Davis,	Ahmad	Jamal
when	**be.PAST.PERF**	**notice.PAST.PART**	by	Miles	Davis,	Ahmad	Jamal

suonava	*in*	*un*	*trio*
suona-va	in	un	trio
play-PAST.IMPF	in	a	trio

'When Ahmad Jamal was noticed by Miles Davis, he was playing in a trio'

'When Ahmad Jamal was noticed by Miles Davis, he was a member of a trio'



⟦**fu notato da Miles Davis**⟧
= λeNotice(md)(aj)(e)
⟦↑[λeNotice(md)(aj)(e)]⟧
= λtλC$\forall$e[C(e) $\leftrightarrow$ Notice(md)(aj)(e) $\wedge$ ><(t, e)]
⟦PERF⟧
= $\lambda\psi\lambda$t$\exists$t'[$\subseteq$(t', t) $\wedge$ $\exists$C[ψ(t')(C) $\wedge$ C$\neq\emptyset$]] (lexicon[34])
⟦E⟧
= ⟦PERF⟧(⟦↑[λeNotice(md)(aj)(e)]⟧)
= $\lambda\psi\lambda$t$\exists$t'[$\subseteq$(t', t) $\wedge$ $\exists$C[ψ(t')(C) $\wedge$ C$\neq\emptyset$]]
(λtλC$\forall$e[C(e) $\leftrightarrow$ Notice(md)(aj)(e) $\wedge$ ><(t, e)])

[34]Note that ψ here is a variable either over expressions of type $< e, < e, t >>$ (i.e., the output of WHEN) or over those of type $< i, < e, t >>$ (i.e., the result of type-shifting an e-abstract). Bonomi's conception of the set *I* of intervals *i* as a subset of the set *E* of events *e* allows him this apparent type ambiguity.

= λt∃t'[⊆(t', t) ∧ ∃C[λtλC∀e[C(e) ↔ Notice(md)(aj)(e) ∧ ><(t, e)](t')(C)
∧ C≠∅]]
= λt∃t'[⊆(t', t) ∧ ∃C[∀e[C(e) ↔ Notice(md)(aj)(e) ∧ ><(t', e)] ∧ C≠∅]]
= λt∃t'[⊆(t', t) ∧ ∃e[Notice(md)(aj)(e) ∧ ><(t', e)]]

[The last equivalence is arrived at as follows. Asserting the existence of a non-empty set *C* of events *e* that coincide with the (contextually relevant) interval *t'* and that are events of Miles Davis noticing Ahmad Jamal is equivalent to asserting the existence of a just such a noticing event *e* that coincides with *t'*.]

⟦**quando**⟧
= WHEN
= λXλYλeλC[X(e) ∧ ∀e'[C(e') ↔ Y(e') ∧ ><(e, e')]]
⟦C⟧
= ⟦WHEN⟧(⟦E⟧)
= λXλYλeλC[X(e) ∧ ∀e'[C(e') ↔ Y(e') ∧ ><(e, e')]]
(λt∃t'[⊆(t', t) ∧ ∃e[Notice(md)(aj)(e) ∧ ><(t', e)]])
= λYλeλC[λt∃t'[⊆(t', t) ∧ ∃e[Notice(md)(aj)(e) ∧ ><(t', e)]](e)
∧ ∀e'[C(e') ↔ Y(e') ∧ ><(e, e')]]
= λYλeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔ Y(e") ∧ ><(e, e")]]
⟦**Ahmad Jamal suonava in un trio**⟧
= λe[Play.trio(aj)(e)]
⟦↑[λePlay.trio(aj)(e)]⟧
= λtλC∀e[C(e) ↔ Play.trio(aj)(e) ∧ ><(t, e)]
⟦IMPF⟧
= λψλt∀t'[⊆(t', t) ∧ Cont(t') ∧ ∃C[ψ(t')(C)] → ∃C[ψ(t')(C) ∧ C≠∅]]
(lexicon[35])
⟦D⟧
= ⟦IMPF⟧(⟦↑[λePlay.trio(aj)(e)]⟧)
= λψλt∀t'[⊆(t', t) ∧ Cont(t') ∧ ∃C[ψ(t')(C)] → ∃C[ψ(t')(C) ∧ C≠∅]]
(λtλC∀e[C(e) ↔ Play.trio(aj)(e) ∧ ><(t, e)])
= λt∀t'[⊆(t', t) ∧ Cont(t') ∧
∃C[λtλC∀e[C(e) ↔ Play.trio(aj)(e) ∧ ><(t, e)](t')(C)] →
∃C[λtλC∀e[C(e) ↔ Play.trio(aj)(e) ∧ ><(t, e)](t')(C) ∧ C≠∅]]
= λt∀t'[⊆(t', t) ∧ Cont(t') ∧
∃C[∀e[C(e) ↔ Play.trio(aj)(e) ∧ ><(t', e)]] →
∃C[∀e[C(e) ↔ Play.trio(aj)(e) ∧ ><(t', e)] ∧ C≠∅]]
= λt∀t'[⊆(t', t) ∧ Cont(t') → ∃e[Play.trio(aj)(e) ∧ ><(t', e)]]
(For an explanation of this last equivalence, see derivation in Appendix A above)
⟦B⟧

[35]The denotation of IMPF here contains a universal quantification over intervals *t'* here instead of over events *e* as above (notice the same is true for the denotation for PERF given above). This is a trivial change allowed by Bonomi's conflation of events and intervals (cf. footnote (34)).

= ⟦C⟧(⟦D⟧)
= λYλeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔ Y(e") ∧ ><(e, e")]]
(λt∀t'[⊆(t', t) ∧ Cont(t') → ∃e[Play.trio(aj)(e) ∧ ><(t', e)]])
= λYλeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔ Y(e") ∧ ><(e, e")]]
(λt∀t"[⊆(t", t) ∧ Cont(t") → ∃e"'[Play.trio(aj)(e"') ∧ ><(t", e"')]])
(variable substitution)
= λeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔
λt∀t"[⊆(t", t) ∧ Cont(t") → ∃e"'[Play.trio(aj)(e"') ∧ ><(t", e"')]](e")
∧ ><(e, e")]]
= λeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔
∀t"[⊆(t", e") ∧ Cont(t") → ∃e"'[Play.trio(aj)(e"') ∧ ><(t", e"')]]
∧ ><(e, e")]]

⟦PAST⟧
= $\lambda\psi \in D_{<e,<e,t>>}$∃t[<(t, t_c) ∧ ∃C[ψ(t)(C) ∧ C≠∅]]

Here it becomes apparent that the Bonomian system is forced to posit an ambiguity in the denotation of PAST. In the derivation of (52) in Appendix A above, PAST was a function of type $<< i, t >, t >$: *λW∈$D_{<i,t>}$∃t[<(t, t_c) ∧ W(t)]*. This function is required for structures where aspect takes scope over WHEN.

In the current derivation, where aspect takes narrow scope under WHEN, the denotation of PAST is by necessity a function of type $<< e, < e, t >>, t >$: *λψ∈$D_{<e,<e,t>>}$ ∃t[<(t, t_c) ∧ ∃C[ψ(t)(C) ∧ C≠∅]]*.

It is apparent that in unifying the in-progress and habitual readings of imperfectivity under a single denotation, Bonomi (1997) must resort to positing an ambiguity for PAST. However, I would argue that this ambiguity is in a sense less radical than that which would be required of any theory that chose to account for the in-progress and habitual readings with an ambiguity in the imperfective. That is, both definitions of PAST serve to locate an interval (the RT) before the UT. A treatment of imperfectivity which allowed it to sometimes have the denotation of an in-progress operator and sometimes that of a habitual one would be a qualitatively different type of ambiguity.

⟦A⟧
= ⟦PAST⟧(⟦B⟧)
= λψ∃t[<(t, t_c) ∧ ∃C[ψ(t)(C) ∧ C≠∅]]
(λeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔
∀t"[⊆(t", e") ∧ Cont(t") → ∃e"'[Play.trio(aj)(e"') ∧ ><(t", e"')]]
∧ ><(e, e")]])
= ∃t[<(t, t_c) ∧
∃C[λeλC[∃t'[⊆(t', e) ∧ ∃e'[Notice(md)(aj)(e') ∧ ><(t', e')]]
∧ ∀e"[C(e") ↔
∀t"[⊆(t", e") ∧ Cont(t") → ∃e"'[Play.trio(aj)(e"') ∧ ><(t", e"')]]

$\wedge$ ><(e, e")]](t)(C)
$\wedge$ C$\neq\emptyset$]]
= $\exists$t[<(t, t_c) $\wedge$
$\exists$C[$\exists$t'[$\subseteq$(t', t) $\wedge$ $\exists$e'[Notice(md)(aj)(e') $\wedge$ ><(t', e')]]
$\wedge$ $\forall$e"[C(e") $\leftrightarrow$
$\forall$t"[$\subseteq$(t", e") $\wedge$ Cont(t") $\rightarrow$ $\exists$e"'[Play.trio(aj)(e"') $\wedge$ ><(t", e"')]]
$\wedge$ ><(t, e")]
$\wedge$ C$\neq\emptyset$]]
= $\exists$t[<(t, t_c) $\wedge$
$\exists$C[$\exists$e'[$\subseteq$(e', t) $\wedge$ Notice(md)(aj)(e')]
$\wedge$ $\forall$e"[C(e") $\leftrightarrow$
$\forall$t"[$\subseteq$(t", e") $\wedge$ Cont(t") $\rightarrow$ $\exists$e"'[Play.trio(aj)(e"') $\wedge$ ><(t", e"')]]
$\wedge$ ><(t, e")]
$\wedge$ C$\neq\emptyset$]]

[The above equivalence holds because *$\exists$t'[$\subseteq$(t', t) $\wedge$ $\exists$e'[Notice(md)(aj)(e') $\wedge$ ><(t', e')]]* is equivalent to *$\exists$e'[$\subseteq$(e', t) $\wedge$ Notice(md)(aj)(e')]*. This is because the fact that *i'* and *e'* coincide—and in this case there is nothing to prevent coincidence from being satisfied by exact overlap (i.e., by subclause (2a) of definition (60))—means that *e'* is a subinterval of *i* and therefore the middleman *i'* can be cut out.]

= $\exists$t[<(t, t_c) $\wedge$
$\exists$e'[$\subseteq$(e', t) $\wedge$ Notice(md)(aj)(e')]
$\wedge$ $\exists$e"[$\forall$t"[$\subseteq$(t", e") $\wedge$ Cont(t") $\rightarrow$ $\exists$e"'[Play.trio(aj)(e"') $\wedge$ ><(t", e"')]]
$\wedge$ ><(t, e")]]

[The above equivalence holds because the assertion that the set *C(e")* is not empty is equivalent to asserting the existence of the an event *e"* with the properties already claimed for *e"*.]

= $\exists$t[<(t, t_c) $\wedge$ $\exists$e'[$\subseteq$(e', t) $\wedge$ Notice(md)(aj)(e')]
$\wedge$ $\forall$t"[$\subseteq$(t", t) $\wedge$ Cont(t") $\rightarrow$ $\exists$e"'[Play.trio(aj)(e"') $\wedge$ ><(t", e"')]]]

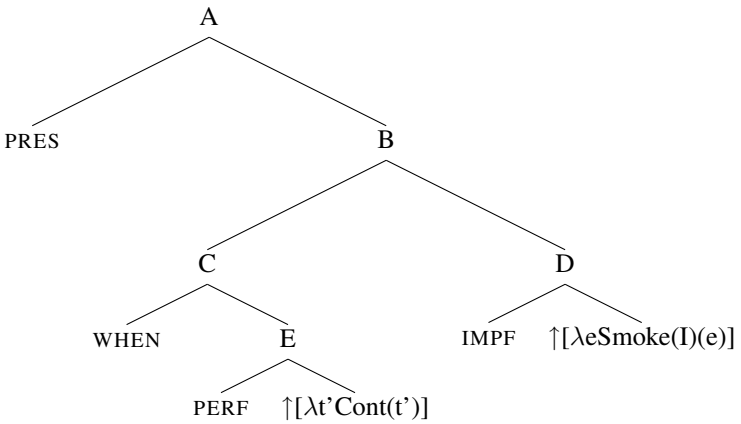
[The above equivalence holds for the by the following argumentation. Since *e"* is an event without content, i.e., there is no event-type predicated of it, we may simply treat it as an interval. Since *e"* is effectively an interval and since it overlaps exactly with the interval *t*, it is indistinguishable from *t* and we may identify the two. This identification permits the removal of the subexpressions *$\exists$e"* and *><(t, e")* and the replacement of all remaining occurrences of *e"* with *t*.]

= $\exists$t[<(t, t_c) $\wedge$ $\exists$e[$\subseteq$(e, t) $\wedge$ Notice(md)(aj)(e)]
$\wedge$ $\forall$t'[$\subseteq$(t', t) $\wedge$ Cont(t') $\rightarrow$ $\exists$e'[Play.trio(aj)(e') $\wedge$ ><(t', e')]]]

Appendix C Derivation of (67)

nitáó'tsisi
nit-∅-**á**-o'tsisii
1-**PRES-IMPF**-smoke(vai)
'I smoke' (HABITUAL)
'I am smoking' (IN-PROGRESS)

BLD (2008, #14716)



The derivation for (67) is nearly identical to that given for (55) in Appendix B above. Therefore only the denotations of nodes B, PRES and A of the above tree are given here.

⟦B⟧
= λeλC[∃i'[⊆(i', e) ∧ ∃i"[Cont(i') ∧ ><(i', i")]] ∧
∀e"[C(e") ↔
∀i"'[⊆(i"', e") ∧ Cont(i"') → ∃e"'[Smoke(I)(e"') ∧ ><(i"', e"')]] ∧
><(e, e")]]
⟦PRES⟧
= $\lambda\psi \in D_{<e,<e,t>>} \exists t[\subseteq(t_c, t) \wedge \exists C[\psi(t)(C) \wedge C \neq \emptyset]]$

[The denotation of PRES is identical to that of PAST except that in the former the UT is made a subinterval of the RT while in the latter the RT precedes the UT. We also observe here that PRES must have the same ambiguity as discussed for PAST above.]

⟦A⟧
= ⟦PRES⟧(⟦B⟧)
= $\exists t[\subseteq(t_c, t) \wedge \exists t'[\subseteq(t', t) \wedge Cont(t')] \wedge$
∀t"[⊆(t", t) ∧ Cont(t") → ∃e[Smoke(I)(e) ∧ ><(t", e)]]]

[The above equivalence is arrived at via the same steps and rationale as that given in the course of the denotation of ⟦PAST⟧(⟦B⟧) above for (55) and therefore is not repeated

here.]

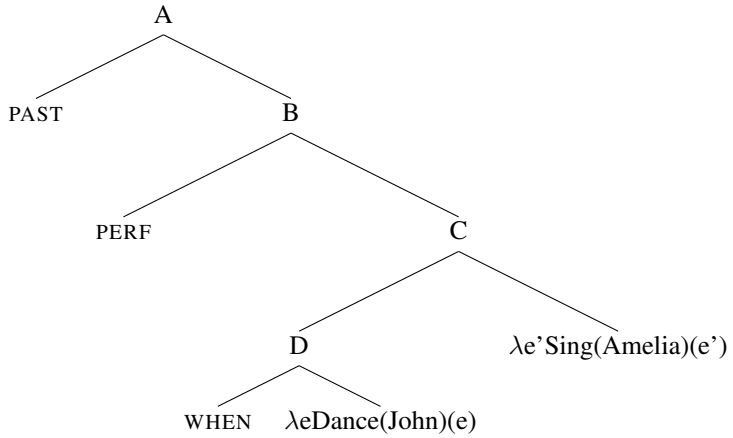
Appendix D Derivation of (70)

otáť'ihpiyi'si	*anná*	*John,*	*anná*	*Amelia*	*iin'ihkít*
ot-**á'**-ihpiyi-hsi	ann-wa	John,	ann-wa	Amelia	inihki
3-**when**-dance-CONJ	DEM-PROX	John	DEM-PROX	Amelia	sing

'When John went up to dance, Amelia sang'
'When John was dancing, Amelia sang'

This example has matching perfective aspect across clauses. According to Bonomi (1997), this signals a structural ambiguity. We consider both structures in turn.

Appendix D.1 Wide Scope Aspect



Much of this derivation is familiar from that given above in A and as a result I only give the derivation from node C up.

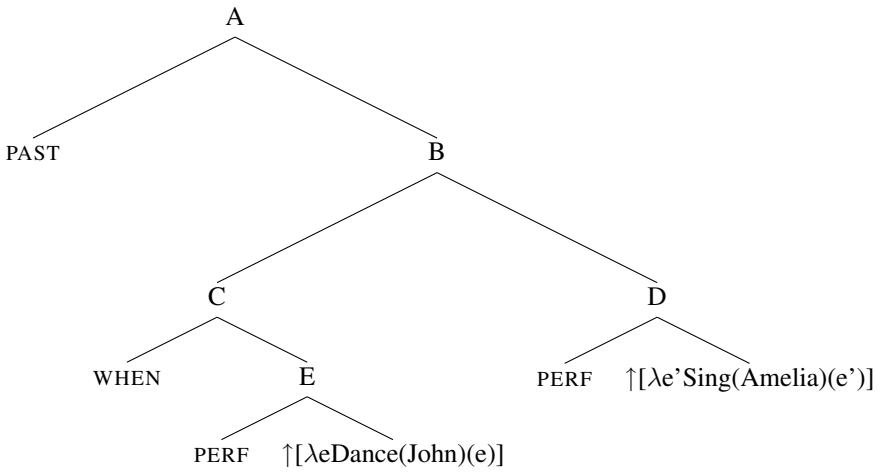
$[\![C]\!]$
$= \lambda e \lambda C[\text{Dance(John)(e)} \wedge \forall e'[C(e') \leftrightarrow \text{Sing(Amelia)(e')} \wedge >\!<(e, e')]]$
$[\![\text{PERF}]\!]$
$= \lambda\psi\lambda t\exists e[\subseteq(e, t) \wedge \exists C[\psi(e)(C) \wedge C \neq \emptyset]]$
$[\![B]\!]$
$= [\![\text{PERF}]\!]([\![C]\!])$
$= \lambda\psi\lambda t\exists e[\subseteq(e, t) \wedge \exists C[\psi(e)(C) \wedge C \neq \emptyset]]$
$(\lambda e \lambda C[\text{Dance(John)(e)} \wedge \forall e'[C(e') \leftrightarrow \text{Sing(Amelia)(e')} \wedge >\!<(e, e')]])$
$= \lambda t\exists e[\subseteq(e, t) \wedge$
$\exists C[\lambda e \lambda C[\text{Dance(John)(e)} \wedge \forall e'[C(e') \leftrightarrow \text{Sing(Amelia)(e')} \wedge >\!<(e, e')]](e)(C)$
$\wedge C \neq \emptyset]]$
$= \lambda t\exists e[\subseteq(e, t) \wedge$
$\exists C[\text{Dance(John)(e)} \wedge \forall e'[C(e') \leftrightarrow \text{Sing(Amelia)(e')} \wedge >\!<(e, e')]$

$\wedge$ C$\neq\emptyset$]]
= λt$\exists$e[$\subseteq$(e, t) $\wedge$ Dance(John)(e) $\wedge$ $\exists$e'[Sing(Amelia)(e') $\wedge$ $><$(e, e')]]

The above equivalence is arrived at as follows. The assertion of a non-empty set *C* means that there is at least one event that coincides with event *e*—remember that *C* is actually a set of ordered pairs $< e, x >$. The assertion (a) that all events *e'* are in *C* iff they are events of Amelia singing and are coincidental with *e* combined with (b) the prohibition against vacuous quantification discussed above[36] licenses the assertion that the set *C(e')* is also non-empty, i.e., that there exists a singing event *e'* that coincides with the dancing event *e*.

⟦PAST⟧
= λW$\in$D$_{<i,t>}$$\exists$t[$<$(t, t$_c$) $\wedge$ W(t)]
⟦A⟧
= ⟦PAST⟧(⟦B⟧)
= λW$\in$D$_{<i,t>}$$\exists$t[$<$(t, t$_c$) $\wedge$ W(t)]
(λt$\exists$e[$\subseteq$(e, t) $\wedge$ Dance(John)(e) $\wedge$ $\exists$e'[Sing(Amelia)(e') $\wedge$ $><$(e, e')]])
= $\exists$t[$<$(t, t$_c$) $\wedge$
λt$\exists$e[$\subseteq$(e, t) $\wedge$ Dance(John)(e) $\wedge$ $\exists$e'[Sing(Amelia)(e') $\wedge$ $><$(e, e')]](t)]
= $\exists$t[$<$(t, t$_c$) $\wedge$
$\exists$e[$\subseteq$(e, t) $\wedge$ Dance(John)(e) $\wedge$ $\exists$e'[Sing(Amelia)(e') $\wedge$ $><$(e, e')]]]

Appendix D.2 Narrow Scope Aspect



⟦↑[λe'Dance(John)(e)]⟧
= λtλC$\forall$e[C(e) $\leftrightarrow$ Dance(John)(e) $\wedge$ $><$(t, e)]
⟦PERF⟧
= $\lambda\psi\lambda$t$\exists$t'[$\subseteq$(t', t) $\wedge$ $\exists$C[ψ(t')(C) $\wedge$ C$\neq\emptyset$]]

[36]It is unclear whether the natural-language prohibition against vacuous quantification is meant to apply in such constructions of the form $\forall$x[A(x) $\leftrightarrow$ B(x)].

$[\![\text{E}]\!]$

$= [\![\text{PERF}]\!]([\![\uparrow[\lambda\text{eDance(John)(e)}]]\!])$

$= \lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e}[\text{Dance(John)(e)} \wedge >\!<(\text{t'}, \text{e})]]$

$[\![\textbf{WHEN}]\!]$

$= \lambda\text{X}\lambda\text{Y}\lambda\text{e}\lambda\text{C}[\text{X(e)} \wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$

$[\![\text{C}]\!]$

$= [\![\text{WHEN}]\!]([\![\text{E}]\!])$

$= \lambda\text{X}\lambda\text{Y}\lambda\text{e}\lambda\text{C}[\text{X(e)} \wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$
$(\lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e}[\text{Dance(John)(e)} \wedge >\!<(\text{t'}, \text{e})]])$

$= \lambda\text{Y}\lambda\text{e}\lambda\text{C}[\lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e}[\text{Dance(John)(e)} \wedge >\!<(\text{t'}, \text{e})]](\text{e})$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$

$= \lambda\text{Y}\lambda\text{e}\lambda\text{C}[\lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]](\text{e})$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$

$= \lambda\text{Y}\lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$

$[\![\text{D}]\!]$

$= [\![\text{PERF}]\!]([\![\uparrow[\lambda\text{e'Sing(Amelia)(e')}]]\!])$

$= \lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e'}[\text{Sing(Amelia)(e')} \wedge >\!<(\text{t'}, \text{e'})]]$

$[\![\text{B}]\!]$

$= [\![\text{C}]\!]([\![\text{D}]\!])$

$= \lambda\text{Y}\lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$
$(\lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e'}[\text{Sing(Amelia)(e')} \wedge >\!<(\text{t'}, \text{e'})]])$

$= \lambda\text{Y}\lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow \text{Y(e')} \wedge >\!<(\text{e}, \text{e'})]]$
$(\lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e'''}[\text{Sing(Amelia)(e''')} \wedge >\!<(\text{t'}, \text{e'''})]])$

$= \lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow$
$\lambda\text{t}\exists\text{t'}[\subseteq(\text{t'}, \text{t}) \wedge \exists\text{e'''}[\text{Sing(Amelia)(e''')} \wedge >\!<(\text{t'}, \text{e'''})]](\text{e'}) \wedge$
$>\!<(\text{e}, \text{e'})]]$

$= \lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow$
$\exists\text{t'}[\subseteq(\text{t'}, \text{e'}) \wedge \exists\text{e'''}[\text{Sing(Amelia)(e''')} \wedge >\!<(\text{t'}, \text{e'''})]] \wedge$
$>\!<(\text{e}, \text{e'})]]$

$= \lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow$
$\exists\text{t''}[\subseteq(\text{t''}, \text{e'}) \wedge \exists\text{e'''}[\text{Sing(Amelia)(e''')} \wedge >\!<(\text{t''}, \text{e'''})]] \wedge$
$>\!<(\text{e}, \text{e'})]]$

$[\![\text{PAST}]\!]$

$= \lambda\psi\in\text{D}_{<e,<e,t>>}\exists\text{t}[<(\text{t}, \text{t}_c) \wedge \exists\text{C}[\psi(\text{t})(\text{C}) \wedge \text{C}\neq\emptyset]]$

$[\![\text{A}]\!]$

$= [\![\text{PAST}]\!]([\![\text{B}]\!])$

$= \lambda\psi\exists\text{t}[<(\text{t}, \text{t}_c) \wedge \exists\text{C}[\psi(\text{t})(\text{C}) \wedge \text{C}\neq\emptyset]]$
$(\lambda\text{e}\lambda\text{C}[\exists\text{t'}[\subseteq(\text{t'}, \text{e}) \wedge \exists\text{e''}[\text{Dance(John)(e'')} \wedge >\!<(\text{t'}, \text{e''})]]$
$\wedge \forall\text{e'}[\text{C(e')} \leftrightarrow$

$\exists$t"[$\subseteq$(t", e') $\wedge$ $\exists$e"'[Sing(Amelia)(e"') $\wedge$ $><$(t", e"')]] $\wedge$
$><$(e, e')]])
= $\exists$t[$<$(t, t_c) $\wedge$ $\exists$C[
λeλC[$\exists$t'[$\subseteq$(t', e) $\wedge$ $\exists$e"[Dance(John)(e") $\wedge$ $><$(t', e")]]
$\wedge$ $\forall$e'[C(e') $\leftrightarrow$
$\exists$t"[$\subseteq$(t", e') $\wedge$ $\exists$e"'[Sing(Amelia)(e"') $\wedge$ $><$(t", e"')]] $\wedge$
$><$(e, e')]](t)(C) $\wedge$
C$\neq\emptyset$]]
= $\exists$t[$<$(t, t_c) $\wedge$ $\exists$C[
$\exists$t'[$\subseteq$(t', t) $\wedge$ $\exists$e"[Dance(John)(e") $\wedge$ $><$(t', e")]]
$\wedge$ $\forall$e'[C(e') $\leftrightarrow$
$\exists$t"[$\subseteq$(t", e') $\wedge$ $\exists$e"'[Sing(Amelia)(e"') $\wedge$ $><$(t", e"')]] $\wedge$
$><$(t, e')] $\wedge$
C$\neq\emptyset$]]
= $\exists$t[$<$(t, t_c) $\wedge$ $\exists$C[
$\exists$e"[$\subseteq$(e", t) $\wedge$ Dance(John)(e")]
$\wedge$ $\forall$e'[C(e') $\leftrightarrow$
$\exists$e"'[$\subseteq$(e"', e') $\wedge$ Sing(Amelia)(e"')] $\wedge$
$><$(t, e')] $\wedge$
C$\neq\emptyset$]]
= $\exists$t[$<$(t, t_c) $\wedge$ $\exists$e"[$\subseteq$(e", t) $\wedge$ Dance(John)(e")] $\wedge$
$\exists$e'[$\exists$e"'[$\subseteq$(e"', e') $\wedge$ Sing(Amelia)(e"')] $\wedge$ $><$(t, e')]]
= $\exists$t[$<$(t, t_c) $\wedge$ $\exists$e"[$\subseteq$(e", t) $\wedge$ Dance(John)(e")] $\wedge$
$\exists$e"'[$\subseteq$(e"', t) $\wedge$ Sing(Amelia)(e"')]]
= $\exists$t[$<$(t, t_c) $\wedge$ $\exists$e[$\subseteq$(e, t) $\wedge$ Dance(John)(e)] $\wedge$
$\exists$e'[$\subseteq$(e', t) $\wedge$ Sing(Amelia)(e')]]

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