Contrast and distributivity in the semantics of alternation*

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1.   Introduction

Languages have various means of talking about events alternating in time, for example, the English adverb *alternately* and its cross-linguistic counterparts:

(1)   John is alternately singing and dancing.

Temporal alternation has two parts to it: temporal disjointness (events of different kinds don't happen simultaneously) and temporal arrangement (an event of one kind is followed by an event of another kind, etc.). However, the previous analyses of *alternately* (Lasersohn 1995, Champollion 2015, a.o.) don't derive the temporal disjointness part.

In this paper I look at novel data on contrastive coordinate constructions, existing in many languages and illustrated in (2) for Russian, that illuminate the previously overlooked role of contrast and distributivity in the semantics of alternation. Cross-linguistically, these constructions are formed with the help of a certain temporal and/or indefinite-like item appearing in each conjunct; in Russian, it's the indefinite-forming particle *to*. Since I will mostly focus on the data from Russian, I will uniformly refer to such constructions as TO-TO constructions.

(2)   Petja to poët, (a   / * i   / * ili) to tancuet.
        Petya TO sings and-contrastive / and-non-contrastive /   or TO dances
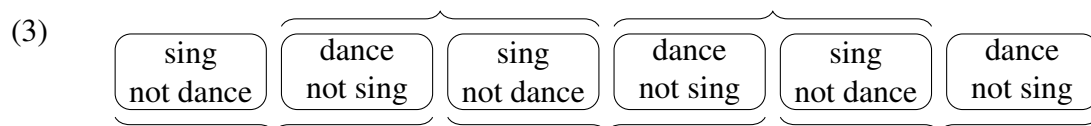   '≈ Petya is alternately singing and dancing.'

Exploring the properties of TO-TO constructions, I propose a modular analysis of alternation involving two independent mechanisms:

(i) Contrast: exhaustification of the focused constituents within the conjuncts capturing the temporal disjointness component.

(ii) Tuple-wise distributivity: distributing the property of containing events of the kinds introduced by the conjuncts over tuples of adjacent elements in an ordered list of time intervals; this mechanism captures the event arrangement pattern.

An example of a scenario that satisfies those conditions is graphically represented in (3) (the pairs of days on which we impose the tuple-wise distributivity requirement are indicated by horizontal braces):

(3)

| sing
not dance | dance
not sing | sing
not dance | dance
not sing | sing
not dance | dance
not sing |

I implement my analysis within quantificational event semantics from Champollion 2015, whose continuized nature allows hassle-free compositional implementation of exhaustification applying locally, to constituents smaller than a sentence.

The highly modular nature of the proposed system allows making small independent adjustments to its components so as to potentially account for the differences among various types of constructions and expressions used to talk about alternation.

The rest of the paper is organized as follows. In section 2 I review the key data points on TO-TO constructions. In section 3 I show how the existing analyses of *alternately* fail to capture the temporal disjointness component of alternation. I lay out the informal gist of my analysis in section 4 and provide a formal implementation in section 5. In section 6 I offer a glimpse into how my analysis could be extended to adverbs like *alternately* and other types of contrastive coordinate constructions. Section 7 is a conclusion.

2.   More on TO-TO constructions

As far as I know, TO-TO constructions have not been discussed in formal semantics literature before, but the Russian TO-TO construction, along with some of its cross-linguistic confrères, has been discussed extensively in Russian descriptive literature (Hegay 1979, 1981, Zavyalov 2000, Ladygina & Rakhilina 2016, to name a few).

As noted in the introduction, the TO elements appearing in each conjunct are typically temporal and/or indefinite-like items. Here is a (vastly incomplete) list of TO elements cross-linguistically:

• Russian: *to* — indefinite-forming particle; demonstrative 'that'; (contrastive) topic marker;

• Ukrainian and Polish: *to* — demonstrative 'that' (Ladygina & Rakhilina 2016);

• Bosnian/Croatian/Serbian: *čas* 'hour', 'moment'; *sad* 'now' (Dunja Veselinović, p.c.);

- Greek: *mia* 'a/one.FEM', likely from 'one time', temporal and spatial uses (Maria Kouneli, p.c.);
- French: *tantôt* (obsolete temporal adverbial, used to mean 'sometimes', now mostly occurs in the TO-TO construction) (Joulin 1990; Philippe Schlenker, p.c.);
- German: *mal* 'moment', 'time', as in *einmal* 'once', *zweimal* 'twice' (Ladygina & Rakhilina 2016; Lucas Champollion, p.c.);
- English: *now* (a somewhat obsolete construction, e.g., *A bevy of girls came and went on the little stage, now singing, now dancing, now performing acrobatic tricks* (1920)).

The TO elements themselves are unlikely to be connectives (contra the descriptive literature cited above), since TO-TO constructions can optionally contain overt connectives. In the languages I have looked at TO-TO constructions are only compatible with overt conjunctions, but not disjunctions[1]. In languages that make the distinction between contrastive and ordinary conjunctions (Russian, Bosnian/Croatian/Serbian), TO-TO constructions are only compatible with the contrastive one. These facts were illustrated in (2) for Russian.

The number of conjuncts in TO-TO constructions is not limited. Here is a Russian corpus example with three TO conjuncts, which also shows that TO conjuncts don't have to be verbal, but can be of any syntactic type:

(4) Sof'ja Kas'janovna vosklicala: « Vsevolod!» — to udivlënno, to
   Sofya Kasyanovna exclaimed Vsevolod TO surprised.ADV TO
   umilënno, to pečal'no.
   touched.ADV TO sadly
   'Sofya Kasyanovna was exclaiming, 'Vsevolod!', in an alternately surprised, touched, and sad manner.'

When combined with an overt Key (the plurality we are distributing over; term used in Choe 1991, Gil 1991, Champollion 2010), TO-TO constructions (at least in Russian) give rise to a non-trivial, *quasi-disjunctive* distributivity pattern, illustrated in (5a).

(5) Po utram Petja to poët, to tancuet.
   over mornings Petya TO sings TO dances
  a. '≈ Each morning Petya is either singing or dancing (and the singing and dancing events form a (roughly) alternating sequence).' [interesting reading]
  b. '≈ Each morning Petya engages in an alternating sequence of singing and dancing.'   [uninteresting reading]

Finally, TO-TO constructions are compatible with overt arrangement adverbials, which affect event arrangement inferences without affecting the temporal disjointness inference or distributivity patterns:

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[1]Although Ladygina & Rakhilina (2016) mention that Estonian and Turkish use disjunctions as the particles themselves in TO-TO-like constructions. Similarly, Mandarin seems to have several TO-TO-like constructions, one of which has the form 'interval or X, interval or Y' (Linmin Zhang, p.c.).

(6) Petja a. poočerёdno / b. besporjadočno pogljadyval to na Mašu, to na Anju.
Petya in-sequence / without-order glanced TO at Masha TO at Anya

a. 'Petya was alternately glancing at Masha and Anya.' [strict]
b. 'Petya was randomly glancing now at Masha, then at Anya.' [random]

TO-TO constructions thus offer a few important insights into the semantics of alternation, which are easy to miss if one looks solely at arrangement adverbials like *alternately*. First, the nature of TO elements cross-linguistically highlights that temporal alternation is more about the properties of time intervals rather than events. Second, by wearing their contrastive nature on their sleeve (especially, in languages like Russian), TO-TO constructions bring out the role of contrast in alternation. Third, they help establish the link between alternation and distributivity. Finally, their compatibility with arrangement adverbials shows that the latter provide only one piece of meaning when it comes to alternation.

Before I move on to showing how I capitalize on these properties of TO-TO constructions to build a modular analysis of alternation, let me quickly review two of the existing analyses of the adverb *alternately* and show what they are missing.

3. Previous analyses of alternation

Semantics of alternation has been primarily discussed in the literature in relation to the challenges adverbs like *alternately* posit for semantics of coordination (e.g., Lasersohn 1995, Winter 1995, Truswell 2007, Champollion 2015). In this section I will very briefly review the analyses of *alternately* in Champollion 2015 and Lasersohn 1995 to illustrate the importance of two of the insights discussed in the previous section, namely, the role of contrast and the necessity to make reference to time intervals.

Champollion's entry for *alternately* requires existence of a sequence of events arranged in a certain manner (the technical details will be covered in section 5):

(7) $[\![\text{alternately}]\!]_{Champ} = \lambda C_{\langle e\langle vt,t\rangle\rangle} \lambda x_e \lambda f_{vt}.\exists e_1,...,e_4[e_1 \supset\subset_T e_2 \supset\subset_T e_3 \supset\subset_T e_4$
$\wedge \{\{e_1,e_2\},\{e_2,e_3\},\{e_3,e_4\}\} \in \mathbf{min}(C(x)) \wedge f(e_1) \wedge ... \wedge f(e_4)]$
$\supset\subset_T$ indicates temporal abutment

This requirement is too weak; it captures the arrangement component of alternation, but not the temporal disjointness one, since nothing in (7) excludes existence of other events of any kind, co-occurring with the events in the sequence.

Conversely, Lasersohn (1995) is specifically trying to target the temporal disjointness inference (the arrangement component is ignored in his analysis), so his entry (in (8b)) yields a set of all complex events, modeled as sets, that contain two temporally non-overlapping events of the kinds introduced by the conjuncts:

(8) a. $[\![\text{sings and dances}]\!]_{Las} = \lambda e.\exists e_1,e_2[\mathbf{sing}(e_1) \wedge \mathbf{danced}(e_2) \wedge e = \{e_1,e_2\}]$
b. $X \in [\![\text{alternately}]\!]_{Las}(P)$ iff $\forall e,e' \in X[X \in P \wedge e \notin P \wedge \neg(\boldsymbol{\tau}(e) \circ \boldsymbol{\tau}(e'))]$
$\boldsymbol{\tau}$ is a temporal trace function returning runtimes of events

However, once again, nothing excludes existence of other events, co-occurring with those that satisfy the resulting predicate.

In other words, neither of the two entries above excludes the simultaneity scenario in (9) for the predicate *alternately sings and dances*:

(9)

| sing | | dance | | sing | | dance | | sing | | dance |
| dance | | sing | | dance | | sing | | dance | | sing |
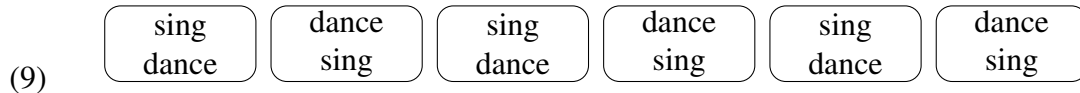
The take-home message of this section is that (i) to correctly capture the semantics of alternation one needs to exclude the simultaneity scenario, (ii) to do so it is not enough to impose requirements on events, but rather one needs to say something about the time intervals that contain those events.

4.   Modular analysis of alternation: informal gist

In this section I lay out the informal gist of my analysis of TO-TO constructions, meant to serve as the basis for a modular semantic analysis of alternation in general.

There are two major independent components in the semantics of TO-TO constructions:

(i) Contrast, capturing the temporal disjointness component:

- I propose that TO-TO constructions are Contrastive Topic (CT) constructions (see Büring 2016 for an overview on CTs), with each instance of TO being a CT.
- The TO element is analyzed as a temporal indefinite adverbial (further decomposable), interpreted roughly as 'at some moment'.
- The Focus within each conjunct is interpreted exhaustively, resulting in conjuncts roughly of the form 'at some moment only *X* (and not *Y, Z,*...)', where *Y, Z,*... are the alternatives from the other conjuncts.
- For example, for (2) we will get conjuncts roughly of the form: 'at some moment sings and doesn't dance' and 'at some moment dances and doesn't sing'.

(ii) Tuple-wise distributivity, capturing the arrangement component:

- We form an ordered list from a temporal Key, supplied overtly, as in (5), or contextually, or existentially closed, as in (2).
- For each *N* adjacent elements of that list (where *N* is the number of conjuncts) we require that each of them contains an event and together these events form a minimal set satisfying the Share (property being distributed; in (2) it's the TP 'Petya TO sings, TO dances'). (This insight is borrowed from Champollion 2015.)
- The ordering of the list is a parameter on the list-building function that determines the arrangement pattern; e.g., chronological order yields strict alternation.

The result is an alternating sequence of singing and dancing events such that runtimes of singing events don't contain any dancing events and vice versa (see (3)).

Order-sensitivity and tuple-wise comparisons have been argued to be relevant for distributivity elsewhere, e.g., in internal readings of comparative adjectives, as in (10a), and of *different*, as in (10b) (Brasoveanu 2011, Bumford 2015, a.o.). Thus, these two components of the system might be independently motivated.

(10)   a.   Every second I am becoming more outnumbered.
         b.   Each boy recited a different poem.

Now, with all the conceptual pieces in place, I will proceed to a formal implementation of my analysis in the next section.

5.   Modular analysis of alternation: implementation

5.1   Framework adopted: Champollion 2015

I implement my analysis within a continuized event semantics from Champollion 2015. Champollion's system is different from standard Neo-Davidsonian event semantics in that instead of denoting sets of events, verbs and their projections denote existential quantifiers over events. Thus, *sings* denotes a set of all sets of events that contain a singing event:

(11) $[\![\text{sings}]\!] = \lambda f_{vt}.\exists e[\textbf{sing}(e) \wedge f(e)]$

Modifiers and θ-lifted arguments in Champollion's system are uniformly of type $\langle\langle vt,t\rangle, \langle vt,t\rangle\rangle$:

(12)   a. $[\![\text{Petya}]\!] = \lambda P_{et}.P(\textbf{petya})$
         b. $[\![\theta]\!] = \lambda Q_{\langle et,t\rangle}\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.Q(\lambda x.V(\lambda e.f(e) \wedge \boldsymbol{\theta}(e) = x))$
         c. $[\![\text{Petya}_{ag}]\!] = [\![\text{AG}]\!]([\![\text{Petya}]\!]) = \lambda V_{\langle vt,t\rangle}\lambda f_{vt}.V(\lambda e.f(e) \wedge \textbf{ag}(e) = x)$

A closure, which is just a trivial continuation, applies at the sentence level (ignoring tense and aspect):

(13)   a. $[\![\text{[closure]}]\!] = \lambda e.\textbf{true}$
         b. $[\![\text{Petya}_{ag}\ \text{sings}]\!] = [\![\text{Petya}_{ag}]\!]([\![\text{sings}]\!])([\![\text{[closure]}]\!]) =$
                $\exists e[\textbf{sing}(e) \wedge \textbf{ag}(e) = \textbf{petya} \wedge \textbf{true}] = \exists e[\textbf{sing}(e) \wedge \textbf{ag}(e) = \textbf{petya}]$

5.2   Step-by-step derivation of (5)

I will now show how my analysis works by deriving (5), repeated below, under the quasi-disjunctive reading of the distributivity pattern.

(5)   Po   utram   Petja to poët, to tancuet.
         over mornings Petya TO sings TO dances
         'Each morning Petya is either singing or dancing and the singing and dancing events
         form an alternating sequence.'

5.2.1 Exhaustifying the VPs

A silent operator [Exh] applies locally to the focused VP within each conjunct:

(14) a. $[\![[\mathrm{Exh}]\, \alpha]\!] = \lambda X.[\![\alpha]\!]^{O}(X) \wedge \forall Y[Y \in [\![\alpha]\!]^{A} \rightarrow \neg Y(X)]$
$[\![\alpha]\!]^{O}$ is the ordinary semantic value of α,
$[\![\alpha]\!]^{A}$ is the set of alternatives to α (Rooth 1992),
$[\![\alpha]\!]^{A}$ can be further contextually restricted
  b. $[\![\mathrm{sings}_{Exh}]\!] = \lambda f_{vt}.\exists e[\mathbf{sing}(e) \wedge f(e)] \wedge \forall V'[V' \in [\![\mathrm{sings}]\!]^{A} \rightarrow \neg V'(f)]$

The alternative set can be "cashed out" at any point of the derivation, but I'll do it here for ease of exposition. Assuming our only alternative is 'dances' ($\lambda f_{vt}.\exists e[\mathbf{dance}(e) \wedge f(e)]$):

(15) $[\![\mathrm{sings}_{Exh}]\!] = \lambda f_{vt}.\exists e[\mathbf{sing}(e) \wedge f(e)] \wedge \neg\exists e'[\mathbf{dance}(e') \wedge f(e)]$

Note that the negated alternatives still contain the continuation variable f, which will allow us to introduce further arguments and modifiers into them, despite applying the [Exh] operator locally to the VP.

5.2.2 Assembling the TO adverbial

The TO adverbial as a whole is a θ-lifted existential quantifier over time intervals. I take the *to* particle in Russian to be an existential determiner that combines with an indeterminate pronoun base as its restrictor to form indefinites. Normally the indeterminate pronoun base would be overt (e.g., *čto-to* — what-to — 'something', *kto-to* — who-to — 'someone', etc.), but in TO-TO constructions the temporal restrictor is silent. In some other languages the restrictor can be overt, but the existential determiner will be silent, or both can be overt.

(16) a. $[\![[\mathrm{TIME}]]\!] = \lambda i.i \in D_i$ [domain, silent in Russian]
  b. $[\![to]\!] = \lambda P_{\alpha t} \lambda P'.\exists x_{\alpha}[P(x) \wedge P'(x)]$ [existential determiner, overt in Russian]
α ranges over types of indeterminate pronoun bases
  c. $[\![[\mathrm{AT}_{\subseteq}]]\!] = \lambda Q_{\langle it,t \rangle} \lambda V_{\langle vt,t \rangle} \lambda f_{vt}.Q(\lambda i.V(\lambda e.f(e) \wedge \boldsymbol{\tau}(e) \subseteq_T i))$ [θ-lifter]
$\subseteq_T$ indicates temporal containment
  d. $[\![\mathrm{TO}]\!] = [\![[\mathrm{AT}_{\subseteq}]]\!]([\![to]\!]([\![[\mathrm{TIME}]]\!])) = \lambda V_{\langle vt,t \rangle} \lambda f_{vt}.\exists i[V(\lambda e.f(e) \wedge \boldsymbol{\tau}(e) \subseteq_T i)]$
[TO adverbial]

5.2.3 Combining the TO adverbial with the VPs

An instance of the TO adverbial modifies each VP:

(17) $[\![\mathrm{TO}\ \mathrm{sings}_{Exh}]\!] = [\![\mathrm{TO}]\!]([\![\mathrm{sings}_{Exh}]\!]) = \lambda f_{vt}.\exists i[\exists e[\mathbf{sing}(e) \wedge f(e) \wedge \boldsymbol{\tau}(e) \subseteq_T i]$
$\wedge \neg\exists e'[\mathbf{dance}(e') \wedge f(e) \wedge \boldsymbol{\tau}(e') \subseteq_T i]]$

5.2.4 Building the conjunction phrase

The two VPs are conjoined intersectively via a silent or overt conjunction:

(18) $[\![\text{TO sings}_{Exh}, \text{TO dances}_{Exh}]\!] = [\![[\&]]\!]([\![\text{dances}_{Exh}]\!])([\![\text{sings}_{Exh}]\!]) =$
$\lambda f_{vt}.\exists i_1[\exists e_1[\textbf{sing}(e_1) \wedge f(e_1) \wedge \boldsymbol{\tau}(e_1) \subseteq_T i_1]$
$\wedge \neg\exists e_2[\textbf{dance}(e_2) \wedge f(e_2) \wedge \boldsymbol{\tau}(e_2) \subseteq_T i_1]]$
$\wedge \exists i_2[\exists e_3[\textbf{dance}(e_3) \wedge f(e_3) \wedge \boldsymbol{\tau}(e_3) \subseteq_T i_2]$
$\wedge \neg\exists e_4[\textbf{sing}(e_4) \wedge f(e_4) \wedge \boldsymbol{\tau}(e_4) \subseteq_T i_2]]$

5.2.5 Adding the rest of the arguments and modifiers

We then proceed to build the TP as usual. In the example at hand, the subject argument 'Petya' combines with the ConjP 'TO sings, TO dances':

(19) $[\![\text{Petya TO sings}_{Exh}, \text{TO dances}_{Exh}]\!] = [\![\text{Petya}_{ag}]\!]([\![\text{TO sings}_{Exh}, \text{TO dances}_{Exh}]\!]) =$
$\lambda f_{vt}.\exists i_1[\exists e_1[\textbf{sing}(e_1) \wedge \textbf{ag}(e_1) = \textbf{petya} \wedge f(e_1) \wedge \boldsymbol{\tau}(e_1) \subseteq_T i_1]$
$\wedge \neg\exists e_2[\textbf{dance}(e_2) \wedge \textbf{ag}(e_2) = \textbf{petya} \wedge f(e_2) \wedge \boldsymbol{\tau}(e_2) \subseteq_T i_1]]$
$\wedge \exists i_2[\exists e_3[\textbf{dance}(e_3) \wedge \textbf{ag}(e_3) = \textbf{petya} \wedge f(e_3) \wedge \boldsymbol{\tau}(e_3) \subseteq_T i_2]$
$\wedge \neg\exists e_4[\textbf{sing}(e_4) \wedge \textbf{ag}(e_4) = \textbf{petya} \wedge f(e_4) \wedge \boldsymbol{\tau}(e_4) \subseteq_T i_2]]$

5.2.6 Applying the [DIST$_{tup}$] operator

Tuple-wise distributivity is done by a specialized silent distributivity operator [DIST$_{tup}$]. First let me define the pieces used in the denotation of this operator:

(20) List-building function, takes a set and returns the list of its members, ordered according to the ordering parameter on the function:

a. $\textbf{list}_O \overset{\text{def}}{=} \lambda s.\iota l.\exists x_1, ..., x_n[s = \{x_1, ..., x_n\} \wedge l = [x_1, ..., x_n]_O]$ [generalized]

b. $\textbf{list}_{\ll} \overset{\text{def}}{=} \lambda s.\iota l.\exists i_1, ..., i_n[s = \{i_1, ..., i_n\} \wedge l = [i_1 \ll ... \ll i_n]]$
[chronological ordering]
$\ll$ indicates temporal precedence

(21) Projecting function, takes a list and returns the member of that list corresponding to the index on the function:

a. $\boldsymbol{\pi}_1([a, b, c]) = a$
b. $\boldsymbol{\pi}_2([a, b, c]) = b$, etc.
c. $\boldsymbol{\pi}_4([a, b, c]) = \#$

(22) Length function (Brasoveanu 2011), takes a list and returns its length:
$\textbf{len} \overset{\text{def}}{=} \lambda l. \begin{cases} \iota n.\boldsymbol{\pi}_n(l) \neq \# \wedge \forall n'[n' > n \to \boldsymbol{\pi}_{n'}(l) = \#] & \text{if} \quad \exists n[\boldsymbol{\pi}_n(l) \neq \#] \\ 0 & \text{if} \quad \forall n[\boldsymbol{\pi}_n(l) = \#] \end{cases}$

(23) Set minimization (Winter 2001), takes a set of sets and returns a set of all minimal sets in that set:
$$\mathbf{min} \overset{\text{def}}{=} \lambda A_{\alpha t} \lambda B_\alpha . B \in A \wedge \forall B'[(B' \in A \wedge B' \subseteq B) \to B' = B]$$

The [DIST_{tup}] operator in (24) takes a verbal projection and a Key (here a temporal one). The Key can also be supplied contextually, in which case the T variable should be left free, or existentially closed. [DIST_{tup}] then makes an ordered list of the members of the Key (here the order will be chronological) and requires that for each N-tuple of adjacent elements in that list (where N is the number of conjuncts) each member of that N-tuple contains an event such that taken together these events form a minimal set that is in the denotation of the verbal projection.
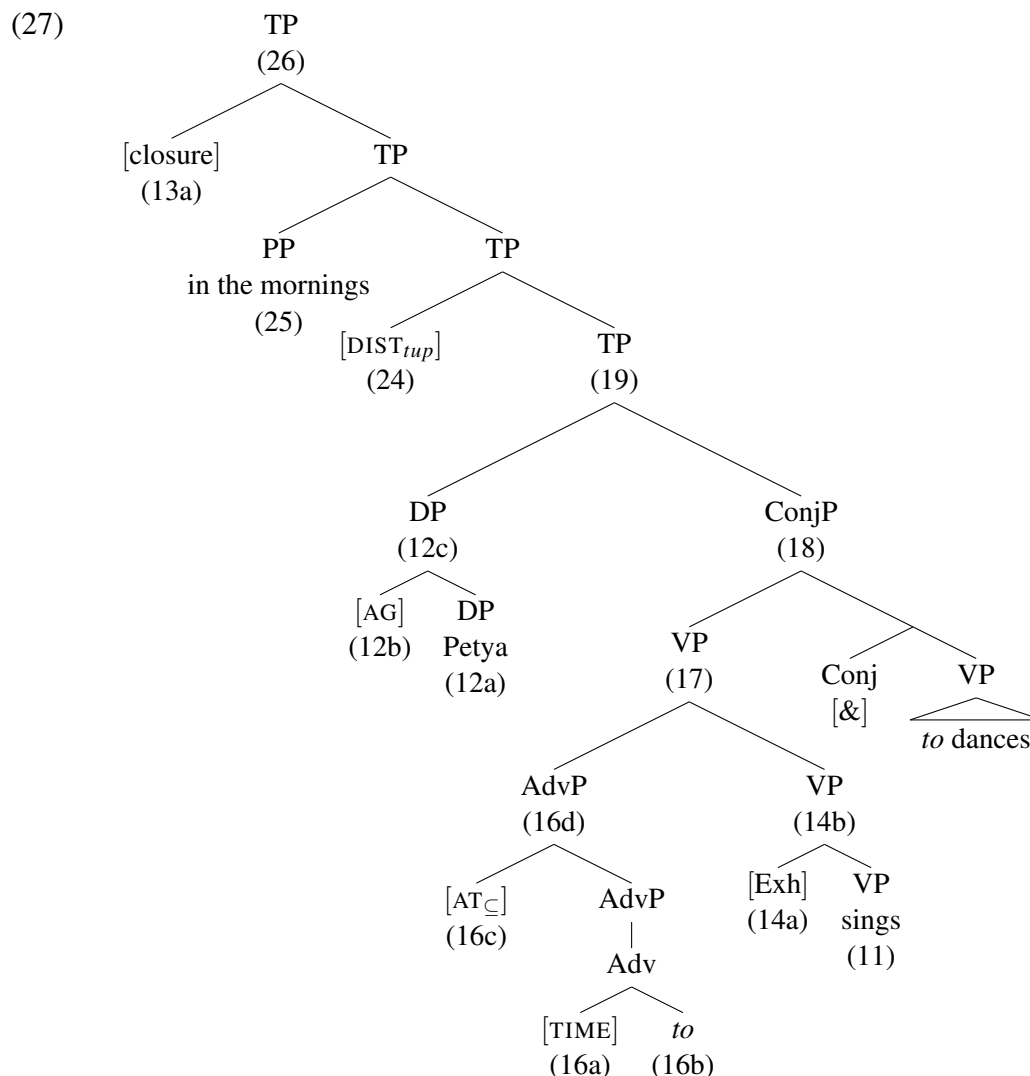
(24) $[[\mathrm{DIST}_{tup}]]^{N,O} = \lambda V_{\langle vt,t\rangle} \lambda T_{it} \lambda f_{vt} . \forall n[n < \mathbf{len}(\mathbf{list}_O(T)) - (N-2) \to$
$\exists e_1,...,e_N[\{e_1,...,e_N\} \in \mathbf{min}(V) \wedge f(e_1) \wedge ... \wedge f(e_N) \wedge \boldsymbol{\tau}(e_1) \subseteq_T \boldsymbol{\pi}_n(\mathbf{list}_O(T)) \wedge$
$... \wedge \boldsymbol{\tau}(e_N) \subseteq_T \boldsymbol{\pi}_{n+(N-1)}(\mathbf{list}_O(T))]]$ $\qquad N = \#$ of conjuncts

The PP 'in the mornings', which will saturate the Key argument of the [DIST_{tup}] operator is treated as the set of all (relevant) mornings:

(25) $[\![\text{in the mornings}]\!] = \lambda i . \mathbf{morning}(i)$

We can now put the pieces together and apply the sentence-level closure to obtain the final result shown in (26). The tree of the derivation is adduced in (27).

(26) $[\![\text{In the mornings Petya TO sings, TO dances}]\!] =$
$[\![\mathrm{DIST}_{tup}]\!]^{2,\ll}([\![\text{Petya TO sings, TO dances}]\!])([\![\text{in the mornings}]\!])([\![\text{closure}]\!]) =$

$\forall n[n < \mathbf{len}(\mathbf{list}_\ll(\lambda i.\mathbf{morning}(i))) \to$	For all positive integers n smaller than the length of the chronological list of mornings
$\exists e,e'[\{e,e'\} \in \mathbf{min}$	there is a pair of events such that
$(\lambda f_{vt}.\exists i_1[\exists e_1[\mathbf{sing}(e_1) \wedge \mathbf{ag}(e_1) = \mathbf{p}$	one of them is an event of Petya singing
$\wedge \boldsymbol{\tau}(e_1) \subseteq_T i_1 \wedge f(e_1)]$	within some time interval
$\wedge \neg\exists e_2[\mathbf{dance}(e_2) \wedge \mathbf{ag}(e_2) = \mathbf{p}$	such that there is no event of Petya dancing
$\wedge \boldsymbol{\tau}(e_2) \subseteq_T i_1 \wedge f(e_2)]]$	within that time interval
$\wedge \exists i_2[\exists e_3[\mathbf{dance}(e_3) \wedge \mathbf{ag}(e_3) = \mathbf{p}$	and the other is an event of Petya dancing
$\wedge \boldsymbol{\tau}(e_3) \subseteq_T i_2 \wedge f(e_3)]$	within some time interval
$\wedge \neg\exists e_4[\mathbf{sing}(e_4) \wedge \mathbf{ag}(e_4) = \mathbf{p}$	such that there is no event of Petya singing
$\wedge \boldsymbol{\tau}(e_4) \subseteq_T i_2 \wedge f(e_4)]]$	within that time interval
$\wedge \boldsymbol{\tau}(e) \subseteq_T \boldsymbol{\pi}_n(\mathbf{list}_\ll(\lambda i.\mathbf{morning}(i)))$	and the runtime of one of these events is a subinterval of the n-th member of the chronological list of mornings
$\wedge \boldsymbol{\tau}(e') \subseteq_T \boldsymbol{\pi}_{n+1}(\mathbf{list}_\ll(\lambda i.\mathbf{morning}(i)))]]$	and the runtime of the other event is a subinterval of the following member of that list.

(27)

TP
(26)

[closure]
(13a)

TP

PP
in the mornings
(25)

TP

[DIST$_{tup}$]
(24)

TP
(19)

DP
(12c)

ConjP
(18)

[AG]
(12b)

DP
Petya
(12a)

VP
(17)

Conj
[&]

VP

VP
to dances

AdvP
(16d)

VP
(14b)

[AT$_{\subseteq}$]
(16c)

AdvP

[Exh]
(14a)

VP
sings
(11)

Adv

[TIME]
(16a)

to
(16b)

6. Extending the analysis to other types of alternation talk

The proposed analysis of TO-TO constructions has many moving pieces that can be adjusted independently of each other so as to capture the semantics of other expressions and constructions used to talk about alternation.

For example, one question to ask at this point is: what is the role of arrangement adverbials like *alternately*? A natural thing to do is to posit silent counterparts of TO elements within the conjuncts under *alternately*. Arrangement adverbs, including *alternately*, then can be analyzed either as overt instantiations of [DIST$_{tup}$] with various values of the ordering parameter on the list-building function or as indicators of that ordering parameter only.

A potential problem with this straightforward approach is that Russian sentences with 'alternately' (*poperemenno/poočerëdno*) but without TO-TO do not have CT prosody and do not license the contrastive 'and'. That said, I personally disprefer Russian examples with 'alternately' but without TO-TO, and adverbs like 'randomly' (*besporjadočno*) cannot en-

code alternation on their own, without TO-TO at all. In any event, one could say this issue is more about how and when contrast is encoded in Russian rather than when exhaustification applies.

A more serious challenge, which I will not address in this paper, is extending the analysis above to account for the uses of *alternately*-like adverbials that don't involve conjunction, discussed by Lasersohn (1992) (the judgements are his):

(28)   a.   John raised each of his fingers in alternation.
        b.   ?John alternately raised each of his fingers.
        c.   %John alternately raised his two hands.

Another direction for extending the analysis is non-temporal alternation. The English adverb *alternately* can be used to talk about spatial alternation, and so can the Greek TO-TO (*mia... mia*) construction (Maria Kouneli, p.c.). Such uses are easy to account for by saying that in these cases the (covert) restrictor of the TO element is a set of locations rather than of time intervals.

Besides, Russian has another type of contrastive coordinate constructions, which I call WH-WH constructions, exemplified in (29). They are very similar to TO-TO constructions, but the CT element in each conjunct is an indeterminate pronoun base of some kind. Hungarian also has a full range of WH-WH constructions (Anna Szabolcsi, p.c.), and Greek has WHEN-WHEN, which has both temporal (default) and spatial uses (Maria Kouneli, p.c.).

(29)   a.   Kogda dožd', (a   / * i   / * ili) kogda sneg.
              WHEN rain   and-contrastive /   and-non-contrastive /   or WHEN snow
              '≈ Sometimes it rains, and sometimes it snows.' (Raining and snowing events
              are randomly distributed throughout some salient period of time; most of the
              time it is not raining and snowing simultaneously.)

        b.   Gde   sneg, (a   / * i   / * ili) gde
              WHERE snow   and-contrastive /   and-non-contrastive /   or WHERE
              grjaz'.
              mud
              '≈ In some areas there is snow, and in some areas there is mud.' (Through-
              out some salient area of space some subareas are covered in snow and some
              in mud; most areas are not covered in both; snow and mud are randomly
              distributed.)

        c.   Kto   el, (a   / * i   / * ili) kto   pil.
              WHO ate.SG and-contrastive /   and-non-contrastive /   or WHO drank.SG
              '≈ Some people were eating, and some were drinking.' (Within a salient set
              everyone was either eating or drinking; most people were not doing both;
              eaters and drinkers were randomly distributed over the event space.)

Under my analysis, one could say that in WH-WH constructions the restrictor of the adverbial occurring in each conjunct is overt while the existential determiner is silent[2].

There are further subtle differences between TO-TO and WH-WH constructions. For one thing, WH-WH constructions favor random distribution rather than strict alternation; for example, WHEN-WHEN in Russian seems poorly compatible with arrangement adverbs like 'alternately', but is compatible with adverbs like 'randomly'. That can be encoded as a lexical restriction on the values of the ordering parameter on $[\mathrm{DIST}_{tup}]$ WH-WH constructions are compatible with.

There is yet another type of contrastive coordinate constructions in Russian, in which the arrangement component does not seem to play any meaningful role: *to li... to li* (*to* + question particle *li*, which is etymologically a part of the disjunctions *ili* and *libo*) and *ne to... ne to* (negation particle + *to*), exemplified in (30) (examples from the corpus). Both are used to convey that the speaker is unsure (cannot figure out/does not remember) which of the conjuncts is true, but only one can be true (and which one is true has to be already determined, i.e., those constructions cannot be used to hypothesize about the future).

(30) a. Nelja smotrit na nego i   vsxlipyvaet — ne   to plačet, ne   to smeëtsja.
          Nelya looks   at him and sobs   NEG TO cries   NEG TO laughs
          'Nelya is looking at him and sobbing, either crying or laughing. (I can't tell which.)'

   b. Na ulice morosil to li   dožd', to li sneg.
       on street drizzled TO LI rain   TO LI snow
       'Either rain or snow was drizzling outdoors. (I can't tell which.)'

Yet, I believe, even *to li... to li*/*ne to... ne to* constructions can be in principle accounted for by adjusting the analysis developed in this paper. They could be analyzed as distribution over possible worlds, with the contrast component yielding the desired exclusive interpretation, and the arrangement component being essentially vacuous.

7.   Conclusion

In this paper I proposed a new analysis of the semantics of temporal alternation, based on the novel data on contrastive coordinate TO-TO constructions in Russian and other languages. The analysis relies on two major independent mechanisms: (i) exhaustification of the focused constituents within the conjuncts with respect to each other, which guarantees that events of the kinds introduced by the conjuncts don't happen simultaneously, and (ii) tuple-wise distributivity, which makes sure that those events are temporally arranged in a certain way. The proposed analysis improves on the previous accounts of temporal alternation, which fail to exclude the simultaneity scenario. The highly modular nature of the analysis allows accounting for various event arrangement patterns, as well as for non-temporal alternation.

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[2]Note that Russian has bare indefinites elsewhere, although their uses are restricted (Yanovich 2005).

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