Contrast and distributivity in the semantics of alternation

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Introducing TO-TO constructions: Languages have various means of talking about events alternating in time. Some of the challenges posited by this alternation talk have been discussed in the semantics literature with respect to the adverb *alternately* (Lasersohn 1995; Champollion 2015, a.o.). I look at novel data on a special type of coordinate construction, existing in many languages, which illuminates the previously overlooked role contrast and distributivity play in the semantics of alternation.

Cross-linguistically, these constructions are formed with the help of a certain temporal and/or indefinite-like item (Russian: *to* — indefinite-forming particle; Bosnian/Croatian/Serbian: *čas* 'hour/moment', *sad* 'now'; French: *tantôt* 'sometimes/earlier/later' (obsolete); German: *mal* 'time/moment'; Greek: *mia* 'a/one.FEM', etc.) appearing in each conjunct (the number of conjuncts is not limited). I focus on the data from Russian, hence, the uniform term 'TO-TO constructions':

(1) 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.'

(1) gives rise to inferences similar, albeit not identical, to those of *alternately*: the events of the kinds introduced by the conjuncts have to be temporally disjoint (i.e. they don't happen simultaneously), and the events of contrasted kinds are arranged in a roughly alternating pattern.

These constructions also give rise to a non-trivial distributivity pattern (which I call 'quasi-disjunctive', because it features a 'switch' from apparent conjunction to essentially disjunction):

(2) 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 a (roughly) alternating sequence).' (one of the readings)

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

(3) Petja poočerëdno / besporjadočno pogljadyval to na Mašu, to na Anju.
Petya in-sequence w/o-order glanced TO at Masha TO at Anya
in-sequence: 'Petya was alternately glancing at Masha and Anya.' (strict alternation)
w/o-order: 'Petya was randomly glancing now at Masha, then at Anya.' (chaotic alternation)

Exploring the properties of TO-TO constructions, I propose a modular analysis under which what we conceptualize as alternation of events arises from the workings of two separate mechanisms:

(i) Contrast: local exhaustification within conjuncts yielding the temporal disjointness inference.
(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 (I borrow the main insight from Champollion's (2015) analysis of *alternately* and link it to distributivity); this component captures the arrangement inferences and the quasi-disjunctive distributivity pattern.

Let us now look at how things work for TO-TO constructions and then come back to *alternately*.

Contrast: I propose that TO-TO constructions are Contrastive Topic (CT) constructions, with each instance of TO being a CT. The TO element is analyzed as a temporal indefinite adverbial (possibly, further decomposable), interpreted roughly as 'at some moment'.

The Focus within each conjunct is interpreted exhaustively (a common claim for CT constructions (Büring 2014, a.o.)), resulting in conjuncts roughly of the form 'at some moment only *X* (and not *Y*, *Z*,…)', where *Y*, *Z*,… are alternatives from the other conjuncts. Thus, in (2) the exhaustified conjuncts will be 'at some moment sings and doesn't dance' and 'at some moment dances and doesn't sing'.

Tuple-wise distributivity: We form an ordered list from a temporal Key (plurality being distributed over; supplied overtly, as in (2), or contextually, or existentially closed), and for each *N* adjacent elements of that list 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'), *N* being the number of conjuncts. 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.

Note that order-sensitivity and tuple-wise comparisons might be relevant for distributivity elsewhere, e.g., in internal readings of comparative adjectives and *different* (Brasoveanu 2011, a.o.).

Implementation: (deriving the strict alternation reading for (2)) I implement my analysis within the continuized event-based framework from (Champollion 2015), in which verbs and their projections denote sets of sets of events ($\langle vt,t\rangle$), and (θ-lifted) arguments and modifiers are of type $\langle\langle vt,t\rangle,\langle vt,t\rangle\rangle$:

(4) $[\![\text{sings}]\!] = \lambda f_{vt}.\exists e[\mathbf{sing}(e) \wedge f(e)]$ (5) $[\![\text{Petya}_{\text{ag}}]\!] = \lambda V_{\langle vt,t\rangle}\lambda f_{vt}.V(\lambda e.f(e) \wedge \mathbf{ag}(e) = \mathbf{p})$

Exhaustification is performed by a silent operator [Exh] applying locally to the focused constituent (here, the verb) within each conjunct. The continuized nature of the chosen framework allows subsequent 'smuggling' of further arguments and modifiers into the rejected alternatives.

(6) $[\![[\text{Exh}]]\!]^{Alt} = \lambda A_{\alpha\beta}\lambda B_{\alpha}.A(B) \wedge \neg\exists A'[A' \in \text{Alt} \wedge A'(B)]$ *Alt* = contextual set of alternatives

(7) $[\![\text{sings}_{\text{Exh}}]\!]^{Alt} = [\![[\text{Exh}]]\!]^{Alt}([\![\text{sings}]\!]) = \lambda f_{vt}.\exists e[\mathbf{sing}(e) \wedge f(e)] \wedge \neg\exists V'_{\langle vt,t\rangle}[V' \in \text{Alt} \wedge V'(f)]$

Our only alternative is 'dances' ($\lambda f_{vt}.\exists e[\mathbf{dance}(e) \wedge f(e)]$), so we can recompute the result with this alternative in mind (we can cash out *Alt* at any point, I am doing it now for presentational purposes):

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

The TO adverbial is treated as a θ-lifted existential quantifier over time intervals:

(9) $[\![\text{TO}]\!] = \lambda V_{\langle vt,t\rangle}\lambda f_{vt}.\exists i[V(\lambda e.f(e) \wedge \boldsymbol{\tau}(e) \subseteq_T i)]$ *i* ranges over time intervals, $\subseteq_T$ indicates temporal containment, $\boldsymbol{\tau}$ is a trace function returning runtimes of events

Tuple-wise distributivity is done by a specialized silent operator [DIST$_{\text{tup}}$] (pieces explained in (11)):

(10) $[\![[\text{DIST}_{\text{tup}}]]\!]^{N,O} = \lambda T_{it}\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.\forall n[n < \mathbf{len}(\mathbf{list}_O(T))-(N-2) \rightarrow \exists e_1,\ldots, e_N[\{e_1,\ldots, e_N\} \in \mathbf{min}(V) \wedge f(e_1) \wedge\ldots\wedge f(e_N) \wedge \boldsymbol{\tau}(e_1) \subseteq_T \boldsymbol{\pi}_n(\mathbf{list}_O(T)) \wedge\ldots\wedge \boldsymbol{\tau}(e_N) \subseteq_T \boldsymbol{\pi}_{n+(N-1)}(\mathbf{list}_O(T))]]$ *N* = # of conjuncts

Combining the pieces together (PP 'in the mornings' is treated as a set of relevant mornings; the VPs are conjoined intersectively) and applying closure [cl] ($\lambda e.\mathbf{true}$), we get the following result for (2):

(11) $[\![\text{In the mornings Petya TO sings, TO dances}]\!] =$ $[\![[\text{DIST}_{\text{tup}}]]\!]^{2,\ll}(\{i \mid \mathbf{morning}(i)\})([\![\text{Petya}_{\text{ag}}]\!]([\![\&]\!]([\![\text{TO}]\!]([\![\text{dances}_{\text{Exh}}]\!]))([\![\text{TO}]\!]([\![\text{sings}_{\text{Exh}}]\!]))))([\![\text{cl}]\!]) =$	
$\forall n[n < \mathbf{len}(\mathbf{list}_{\ll}(\{i \mid \mathbf{morning}(i)\})) \rightarrow$	For all positive integers *n* smaller than the length of the chronological list of mornings
$\exists e\exists e'[\{e, e'\} \in \mathbf{min}$	there is a pair of events such that
$(\lambda f.\exists i_1[\exists e_1[\mathbf{sing}(e_1) \wedge f(e_1) \wedge \mathbf{ag}(e_1) = \mathbf{p} \wedge \boldsymbol{\tau}(e_1) \subseteq_T i_1]$	one of these events is an event of Petya singing within some time interval
$\wedge \neg\exists e'_1[\mathbf{dance}(e'_1) \wedge f(e'_1) \wedge \mathbf{ag}(e'_1) = \mathbf{p} \wedge \boldsymbol{\tau}(e'_1) \subseteq_T i_1]]$	such that there is no event of Petya dancing within that time interval
$\wedge \exists i_2[\exists e_2[\mathbf{dance}(e_2) \wedge f(e_2) \wedge \mathbf{ag}(e_2) = \mathbf{p} \wedge \boldsymbol{\tau}(e_2) \subseteq_T i_2]$	and the other one is an event of Petya dancing within some time interval
$\wedge \neg\exists e'_2[\mathbf{sing}(e'_2) \wedge f(e'_2) \wedge \mathbf{ag}(e'_2) = \mathbf{p} \wedge \boldsymbol{\tau}(e'_2) \subseteq_T i_2]])$	such that there is no event of Petya singing within that time interval
$\wedge\, \boldsymbol{\tau}(e) \subseteq_T \boldsymbol{\pi}_n(\mathbf{list}_{\ll}(\{i \mid \mathbf{morning}(i)\}))$	and the runtime of one of these events is a subinterval of the *n*-th member of the chronological list of mornings
$\wedge\, \boldsymbol{\tau}(e') \subseteq_T \boldsymbol{\pi}_{n+1}(\mathbf{list}_{\ll}(\{i \mid \mathbf{morning}(i)\}))]]$	and the runtime of the other event is a subinterval of the following member of that list.

Back to *alternately*: Existing analyses of *alternately* fail to capture the temporal disjointness inference. For example, Champollion's (2015) entry for *alternately* requires existence of events arranged in a certain manner, which, on its own, does not exclude the simultaneity scenario, since we can isolate an event of kind *X* even if it is happening simultaneously with an event of kind *Y*:

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

Lasersohn's (1995) analysis has the same problem for the same reason (even though it specifically targets the disjointness rather than the arrangement inference):

(13) a. $[\![\text{sang and danced}]\!]_{Las} = \lambda e.\exists e_1\exists e_2[\mathbf{sing}(e_1) \wedge \mathbf{dance}(e_2) \wedge e = \{e_1, e_2\}]$

b. $X \in [\![\text{alternately}]\!]_{Las}(P)$ iff $\wedge\, \forall e, e' \in X[X \in P \wedge e \notin P \wedge \neg(\boldsymbol{\tau}(e) \circ \boldsymbol{\tau}(e'))]$

TO-TO constructions, being CT constructions with temporal indefinites as CTs, reveal the relevance of Focus exhaustification with respect to time intervals for the temporal disjointness inference. Extending the present analysis to arrangement adverbs like *alternately* will then require positing silent counterparts of TO elements within the conjuncts under *alternately*. Arrangement adverbs then can be analyzed either as overt instantiations of [DIST$_{\text{tup}}$] with various values of the ordering parameter on **list** or as indicators of that ordering parameter only. A compositional implementation of this idea, however, is a bit non-trivial and is left for future research.

Selected references: Brasoveanu, A. 2011. *L&P* 34(2). Büring, D. 2014. (Contrastive) Topic. In *Handbook of Information Structure*. Champollion, L. 2015. *L&P* 38(1). Lasersohn, P. 1995. *Plurality, conjunction and events*.