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.

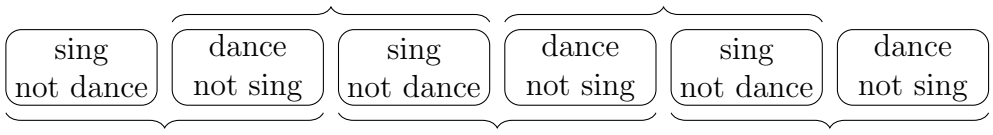
- Temporal alternation has two parts to it: temporal disjointness and arrangement of events of contrasted kinds. However, the previous analyses of *alternately* (Champollion 2015; Lasersohn 1995, a.o.) don't derive the temporal disjointness part.
- I look at novel data on contrastive coordinate constructions, 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.

  (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: 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; this component captures the arrangement pattern.

(3) 

2. More on TO-TO constructions

- Elements used in TO-TO constructions cross-linguistically (incomplete list):
  - Russian: *to* — indefinite-forming particle; demonstrative 'that'; (contrastive) topic marker;
  - Ukrainian and Polish: *to* — demonstrative 'that' (Ladygina and Rakhilina, in print);
  - BCS: *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 and Rakhilina, in print; 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)).

- You can have more than two conjuncts in TO-TO constructions:

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

- A link to distributivity: TO-TO constructions (at least in Russian) give rise to a non-trivial, 'quasi-disjunctive' distributivity pattern:

  (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]

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

  (6) Petja poočerëdno / besporjadočno pogljadyval to na Mašu, to na Anju.
  Petya in-sequence / without-order glanced TO at Masha TO at Anya
  in-sequence: 'Petya was alternately glancing at Masha and Anya.' [strict alternation]
  without-order: 'Petya was randomly glancing now at Masha, then at Anya.' [chaotic alternation]

3. Previous analyses of alternation

- Existing analyses of *alternately* fail to capture the temporal disjointness inference.
- Champollion's (2015) analysis of *alternately* requires existence of a sequence of events arranged in a certain manner:

  (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

- Lasersohn's (1995) analysis explicitly targets the temporal disjointness inference:

  (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

- Neither entry excludes the simultaneity scenario in (9), since you can always isolate an event of kind X even if it is happening simultaneously with an event of kind Y.

(9)

sing dance	dance sing	sing dance	dance sing	sing dance	dance sing

4. Proposal: contrast and distributivity as independent modules

- 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 2016, 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.
  - 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'.
- Tuple-wise distributivity:
  - We form an ordered list from a temporal Key (i.e., the plurality being distributed over), supplied overtly, as in (5), or contextually, or existentially closed, as in (2).
  - For each N adjacent elements of that list (N = 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 (5) it's the TP 'Petya TO sings, TO dances'). (The 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 might be relevant for distributivity elsewhere, e.g., in internal readings of comparative adjectives (10a) and *different* (10b) (Brasoveanu 2011, a.o.).

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

5. Implementation

- Framework adopted: continuized event semantics from Champollion 2015.
  - Verbs and their projections denote sets of sets of events ($\langle vt, t\rangle$):

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

  - Modifiers and θ-lifted arguments 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. $[\![\text{Petya}_{ag}]\!] = [\![[\theta]]\!]([\![\text{Petya}]\!]) = \lambda V_{\langle vt,t\rangle}\lambda f_{vt}.V(\lambda e.f(e) \wedge \textbf{ag}(e) = x)$

– Sentence-level closure is just a trivial continuation:

(13) $[\![[\text{closure}]]\!] = \lambda e.\textbf{true}$

(14) $[\![\text{Petya}_{ag}\ \text{sings}]\!] = [\![\text{Petya}_{ag}]\!]([\![\text{sings}]\!])([\![[\text{closure}]]\!]) = \exists e[\textbf{sing}(e) \wedge \textbf{ag}(e) = \textbf{petya} \wedge \textbf{true}]$

- Reasons for adopting Champollion's framework:
  – It's easy to do intersective conjunction and retrieve information from individual conjuncts via set minimization.
  – Exhaustification can be done locally (at a level smaller than a sentence), and the continuized nature of the chosen framework allows subsequent 'smuggling' of further arguments and modifiers into the rejected alternatives.
- Deriving (5), repeated here for convenience, under the strict alternation reading:

(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.'

– Exhaustification of VP's:
  ◦ A silent operator [Exh] applies locally to the focused VP's ('sings' and 'dances') within each conjunct:

(15) a. $[\![[\text{Exh}]]\!]^{Alt} = \lambda A_{\alpha\beta}\lambda B_{\alpha}.A(B) \wedge \neg\exists A'[A' \in Alt \wedge A'(B)]$
Alt is the set of relevant alternatives (here: contextually supplied)
b. $[\![\text{sings}_{Exh}]\!] = [\![[\text{Exh}]]\!]([\![\text{sings}]\!]) = \lambda f_{vt}.\exists e[\textbf{sing}(e) \wedge f(e)] \wedge \neg\exists V'[V' \in Alt \wedge V'(f)]$

  ◦ Cashing out the alternative set: can happen at any point of the derivation (and probably should happen much later), but I'll do it here for ease of exposition. Assuming our only alternative is 'dances':

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

– Assembling the TO adverbial to obtain a θ-lifted existential quantifier over time intervals and combining an instance of TO with each exhaustified VP:

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

d. $[\![\textsc{to}]\!] = [\![[\textsc{at}_{\subseteq}]]\!]([\![to]\!]([\![[\textsc{time}]]\!])) = \lambda V_{\langle vt,t\rangle}\lambda f_{vt}.\exists i[V(\lambda e.f(e) \wedge \boldsymbol{\tau}(e) \subseteq_T i)]$
(TO adverbial)

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

– The two VP's are conjoined intersectively via a silent or overt conjunction:

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

– The subject argument 'Petya' combines with the ConjP 'TO sings, TO dances':

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

– Tuple-wise distributivity is done by a specialized silent distributivity operator $[\textsc{dist}_{tup}]$:

(21) List-building function:

a. $\mathbf{list}_O \stackrel{\text{def}}{=} \lambda s.\iota l.\exists x_1, ..., x_n[s = \{x_1, ..., x_n\} \wedge l = [x_1, ..., x_n]_O]$ (generalized)

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

(22) Projecting 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]) = #

(23) Length function (Brasoveanu 2011):

$$\mathbf{len} \stackrel{\text{def}}{=} \lambda l.\begin{cases} \iota n.\boldsymbol{\pi}_n(l) \neq \# \wedge \forall n'[n' > n \rightarrow \boldsymbol{\pi}_n(l) = \#] & \text{if } \exists n[\boldsymbol{\pi}_n(l) \neq \#] \\ 0 & \text{if } \forall n[\boldsymbol{\pi}_n(l) = \#] \end{cases}$$

l ranges over lists

(24) Set minimization (Winter 2001):
$\mathbf{min} \stackrel{\text{def}}{=} \lambda A_{\alpha t}\lambda B_{\alpha}.B \in A \wedge \forall B'[(B' \in A \wedge B' \subseteq B) \rightarrow B' = B]$

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

– PP 'in the mornings' is treated as a set of relevant mornings:

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

– Putting the pieces together and applying closure:

(27)

⟦In the mornings Petya TO sings, TO dances⟧ = ⟦⟦DIST$_{tup}$⟧⟧$^{2,\ll}$(⟦in the mornings⟧)(⟦Petya TO sings, TO dances⟧)(⟦⟦closure⟧⟧)	
$\forall n[n < \mathbf{len}(\mathbf{list}_{\ll}(\lambda i.\mathbf{morning}(i))) \rightarrow$	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 these events 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 one 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.

6. Back to *alternately*

- How can we extend the analysis I propose for TO-TO constructions to *alternately* and its cross-linguistic counterparts?
- 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.
- Potential problems:
  - The examples with arrangement adverbs, but without TO-TO in Russian do not have CT prosody and do not license the contrastive 'and'.
  - Compositional implementation is a bit tricky.

7. Conclusion

- I have looked at novel data on alternation-encoding contrastive coordinate constructions (in Russian and other languages), which make the role of contrast and distributivity in the semantics of alternation particularly salient.
- Based on the properties of TO-TO constructions, I have argued for a modular analysis of temporal alternation that incorporates an exhaustification-based contrast component and a distributivity component and, thus, captures both the temporal disjointness and event arrangement ingredients of alternation.

- The modular nature of the analysis should allow it to be:
  - easily modifiable to account for potential cross-linguistic differences;
  - easily extendable to spatial uses of TO-TO (impossible in Russian, but possible, for example, in Greek) and to similar contrastive coordinate constructions, and in particular, the WH-WH constructions (existing at least in Russian, Hungarian, and Greek), exemplified below for Russian:

(28) 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.' (More precisely: raining and snowing events are randomly distributed throughout some salient period of time; most of the time it's not raining and snowing simultaneously.)

b. Gde sneg, (a / * i / * ili) gde grjaz'.
WHERE snow and-contrastive / and-non-contrastive / or WHERE mud
'≈ In some areas there is snow, and in some areas there is mud.' (More precisely: throughout 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.' (More precisely: within a salient set everyone was either eating or drinking; most people weren't doing both; eaters and drinkers were randomly distributed over the event space.)

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