How to Escape the Stranglehold of Encodingism: Dynamic Syntax, Process and Interaction

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https://www.Dynamicsyntax.org

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Prologue: Accepting the Bickhard challenge to cognitive science

Step 1: The outset: DS as a model of the understanding process

Step 2: DS modelling of syntax and morpho-syntax generalisations

Step 3: Modelling dialogue - a surprise gift

Step 4: The collapse of the competence-performance divide

Step 5: DS-TTR Towards a multi-modal world of social interaction

Step 6: Final escape from encodingism? ..... for us all?

Outline

Catching up with the lead of (quantum) physics

The Bickhard challenge: Psychology/linguistics 100 years out of date, fundamentally flawed, and needs radical overhaul:

Process is now the dominant language of science not particles

* Properties of any entity are nothing other than the way in which that entity influences/interacts with others Rovelli 2021,p. 69
* The fundamental constituents of the world are dynamic quantum fields in a dynamic space-time; and they are inherently processes, and always in flux.
* Processes do not have inherent boundaries so boundaries must be explained not assumed Bickhard 2009, in prep

What has to be taken as basic in any model:

* relations, process dynamics, nondeterminism, context-dependency, and interaction.

Facing up to Bickhard's challenge

A Explaining cognition and its emergence, hence language, requires an "interactivist" process-based framework, reflecting:

(i) adaptation via differentiation and (modal/future) anticipation
(ii) interaction in context, as essential to adaptation,
(iii) coordination relative to local context,
(iv) representation and individuation emergent, not primitive
(v) no inbuilt condition of mindreading
(vi) capacity to recognise and correct errors essential to learning

B All code models of language of fixed rules assigning fixed structure/content to strings ("encodingism") fail to match these requirements: they do not allow for flexibility, gradience, change, variation, learning, cross-party interaction Bickhard 2009 i.a.

Can any of us abandon encodingism and yet have a substantial grammar framework? Is Dynamic Syntax (DS) a putative case study?

Outline

Modelling interpretation process for Relevance Theory

The initial goal of Dynamic Syntax (DS) was pragmatic

- Objective: to model the incremental goal-driven process of constructing tree-representations of context-relative content ('the logical form of the proposition expressed').
- Underspecification +modelling **process of update** at its core

The surprise: Model of LF construction process was a putative grammar

The three gifts from the outset:

(i) *Labelled Type Deduction* *LDS* Gabbay 1996: labels express contraints on content and process, type deduction over low types, hence **optimal display of proof transitions**

(ii) *Epsilon calculus* for the labels Meyer-Viol 1985 . *Epsilon terms* witness accumulating content, low type, **transparent proof dynamics**

(iii) *Logic of Finite Trees* *LOFT* Blackburn & Meyer-Viol 1994: the underpinning for defining how incremental processing of word sequences yields emergent growth of tree representations of content

"Syntax": top-down/bottom-up building of LF structure

Goal-driven context-dependent parsing actions induces pairs of word-sequence and content; sewing the seeds of an interactivist account:

(i) **LOFT defining modal relations**

- from mother to daughter nodes $\langle\downarrow_0\rangle X, \langle\downarrow_1\rangle X$ and their inverse, for argument and functor daughter
- a *domination* relation $\langle\downarrow_*\rangle$ and its inverse $\langle\uparrow_*\rangle X$, which is *being dominated by*, then a local variant $\langle\uparrow_0\rangle\langle\uparrow_1^*\rangle X$, domination holding in a single predicate-argument array

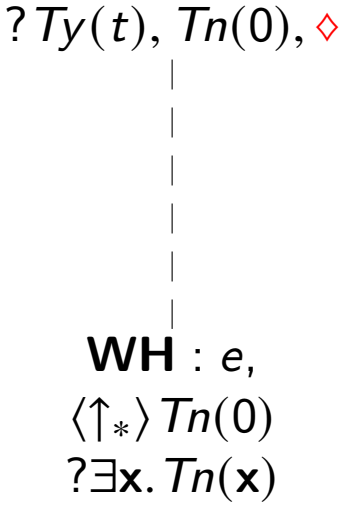
(ii) **LDS labelled formula + type** as node decorations, with **requirements**, $?X$ for any X, anticipations of update inducing underspecifications + subsequent update of node decorations (anaphora, ellipsis) AND of relations (so no movement or inversion)

(iii) **Action language for inducing transitions between states**. All actions (computational/lexical) are in same conditional format

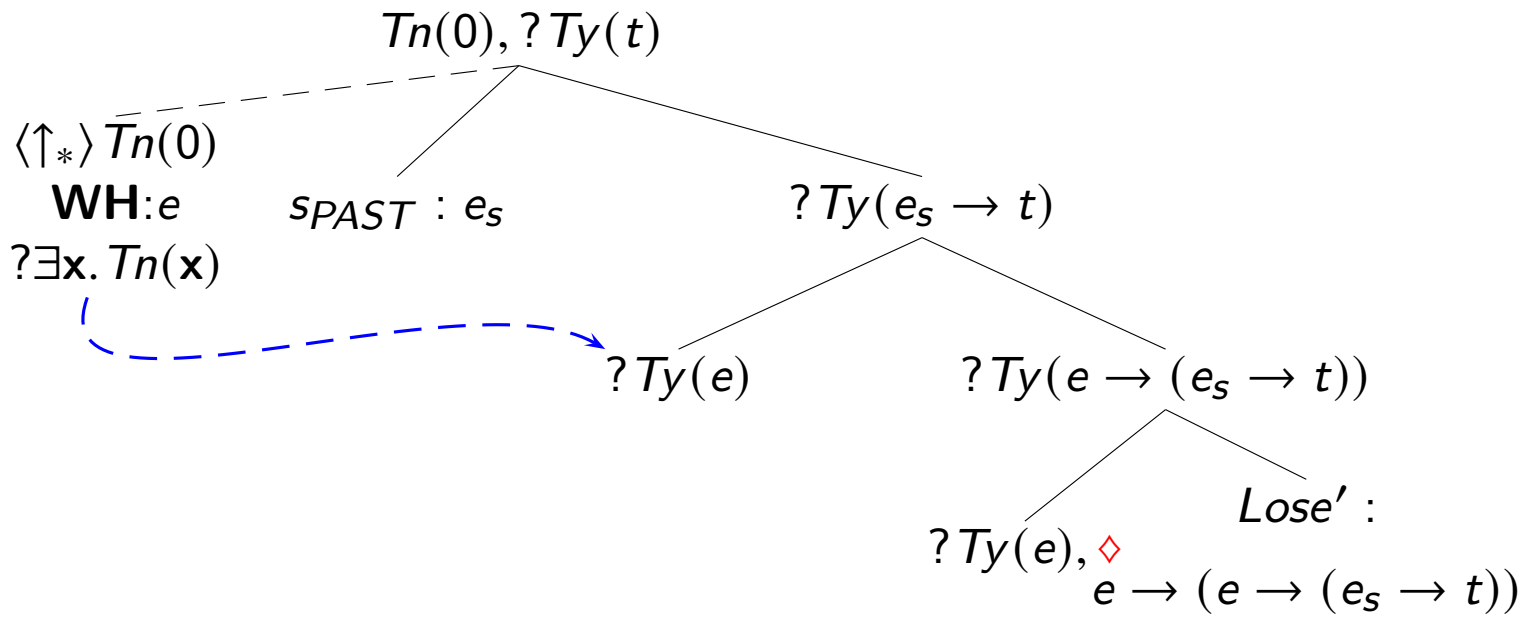
Though the outcome is structure, the process is a sequence of actions reflecting incremental real-time emergence of partial structures

Inter-play between lexical- and tree development actions

Processing *Who*



Processing *Who lost*



Actions include building of (underspecified) node relations, (underspecified) **formula** decorations, assigning/compiling decorations, all triggered by **anticipatory constraints** on **structure and content update**

Compound structures also induced as additional quasi-independent structure (relative clauses, adjuncts, coordination), signalled by items initiating such "linked tree" transitions, the paired trees constrained to share a term
Inference also may be guided eg by *even*, *only*, *but*, *after all*, *however*.

So actions are the core of the shifting context-content updates

Outline

Evaluating DS grammar: solving (morpho-)syntax puzzles

The dynamics of how interpretation incrementally built up provide process-based solutions replacing invocation of: multiple levels, construction-specific stipulations, and massive ambiguity.

(i) Puzzles for syntacticians:

- left-right asymmetries and word-order effects solved by articulating interaction between linked context trees and tree-internal structures.

  'Information structure' insights modelled directly:

  (Japanese, Korean, Kazakh, Hindi, Greek, Spanish, Rangi, Bantu, Chinese)

(ii) Historical and variational puzzles for morphologists:

- **Clitic (clustering) phenomena modelled directly**
  - Spanish clitics + diachronic word-order changes; Greek clitic-cluster variation/change, Bantu agreement variability;

  Bouzouita & Chatzikyriakidis 2009, Chatzikyriakidis, S. & Kempson, R. 2011, Chatzikyriakidis & Gibson 2017, i.a.

Testing LOFT basis for NL syntax: syntactic universals?

(iii) **Universal constraint** precluding multiple-NP long-distance dependency?
'Only 1 unfixed node of a type at any point in building process'

(1) *The document, the spy, I reported that the journalist had given

- **Counterexample** Verb-final languages as preverbal NPs in any order?

(2)

syorui-o	zyaaranisuto-ga	supai-ni	watasita
document-OBJ	journalist-SUBJ	spy-DAT	gave

Japanese

The journalist gave the document to the spy

Kempson & Kiaer 2010

- **Resolution:** Case suffixes induce immediate updating of an initially "locally unfixed node" to the position the suffix locally determines.

Further puzzle?: Paired fronted NPs can be distant from embedded verb in those languages but must be resolved in the same local domain:

(3)

syorui-o	supai-ni	keisatu-ga	zyaaranisuto-ga	watasita	koohyoosita
document-OB	spy-DAT	police-SUB	journalist-SUBJ	gave	reported

The police reported that the journalist gave the document to the spy

Resolution: Restriction is directly predicted since building unfixed node as platform can be input to building locally unfixed nodes (distinct modality)

Functional underpinning of universal constraints?

- **Strong confirmation from morpho-syntax:** Idiosyncratic preverbal "clitic-clusters" in Romance languages echo the constraint, precluding certain clitic/affix sequences with no apparent semantic explanation.
- **Explanation**: Clitic clusters are a diachronic freezing of interweaving structural and pragmatic options in source language via routinisation into lexically defined clusters. Only these possible options in the source language have any reflex in subsequent emergent languages. (Bouzouita & Chatzikyriakidis 2009, Chatzikyriakidis & Kempson 2011, Kempson et al 2013, Chatzkyriakidis 2021)
- From the DS perspective, we expect any supposedly universal constraint on emergent structure to be a cognition-general constraint. But is the constraint more general even than that?

  Functional Underpinning: No direct copy of processes is ever possible in any domain, as every transition nontrivially yields a novel context for the next update. *Adjunction is by definition a domain-development initiator, in principle not replicable; Local *Adjunction interfaces with case update, updating the tree relation, hence a context changer.

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  Echoing the broad quantum mantra? 'All processes are context-relative'

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Why dialogue coordination so challenging for linguists

Agents switch roles across ALL syntactic and semantic dependencies, relying on the manifestness of actions to all parties to ensure smooth interchange while ensuring "correct" forms and yet flexibility of meaning:

* **local anaphor dependency but shifting lexical content**

  (4) Ruth: I'm afraid I burned the kitchen ceiling.
  Michael: Did you burn
  Ruth: myself? No, fortunately not. Well, only my hair.

* **WH-gap dependency** (canonical evidence for "movement")

  (5) A: Which unit are we thinking we should . . .
  B: axe?/*axed? None.

* **quantifier variable dependency**

  (6) A: Has every gymnast handed in her
  B: blood sample?
  A: or even any saliva kits?

* **determiner noun dependency**

  (7) Carer: Old McDonald had a farm... On that farm he had a . . .
  Child: cow/*cows.

No specific prior proposition/goal/speech-act needed

Interruptions before proposition fixed (precluded by syntax/semantic ellipsis accounts):

(8) A. They X-rayed me, and took a urine sample, took a blood sample. Er, the doctor

B: Chorlton?

A: Chorlton, mhm, he examined me..... [BNC]

Possibly no fully determined proposition anticipated (precluded by most)

(9) A: Covent Garden?

B: Right at the lights. Then straight on up

Content/intentions develop during exchange (precluded by Pickering & Garrod i.a.)

(10) A: It's obvious from what you say . . . B: that you are wrong

And children can participate well before mind-reading possible:

(11) Nursery teacher: And your name is ...

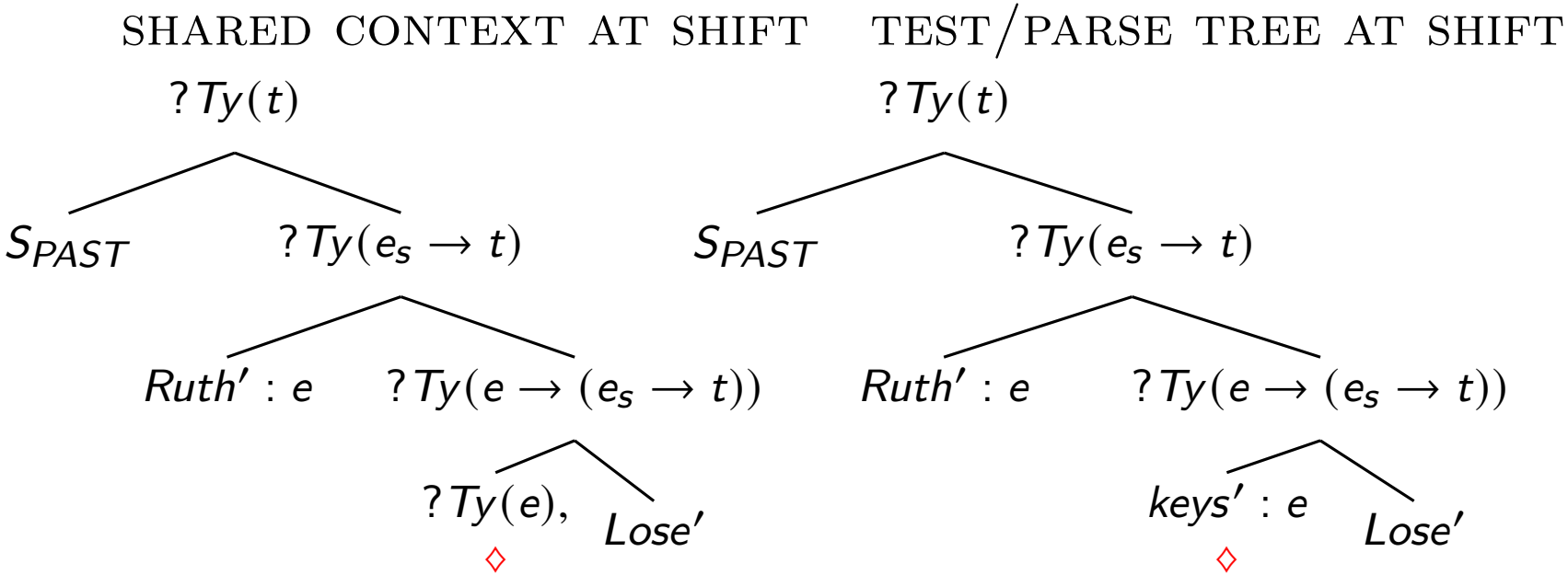
Child : Mary

Interaction is essential

Split utterances: co-building structure in context

In DS, actions predicted to underpin both speech and understanding. Continual predictions of upcoming input leads to lexical access allowing take-over and new goal:

(12) **Ruth**: I've lost. . . **Hugh**: keys? (holding them up)



Coordination is the immediate consequence, without special fragment classification. Given the words are manifest, interaction directly achieved without mind reading.

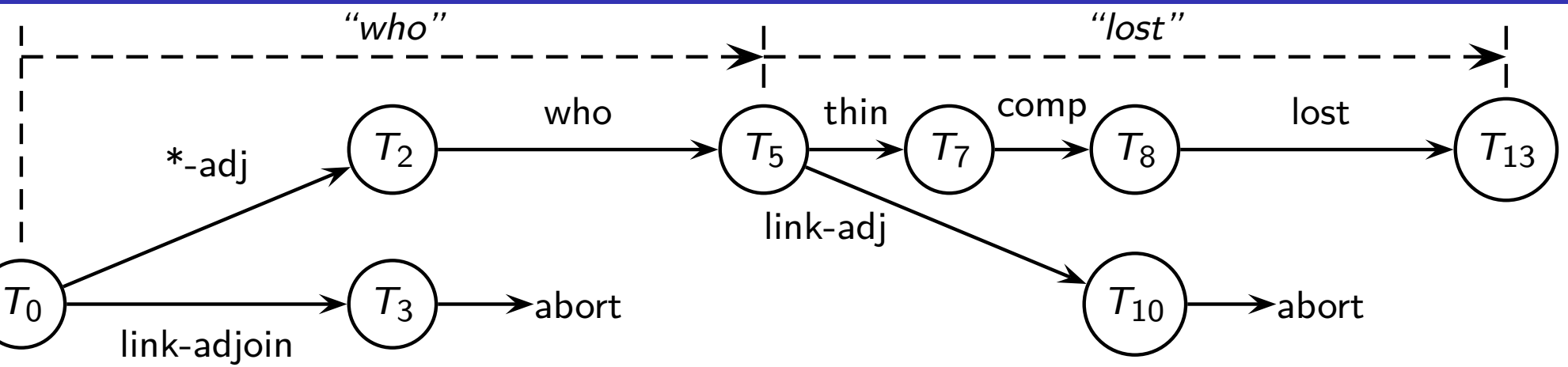
Interim DS checklist against Bickhard desiderata

DS promises to provide an explanatory basis for

- Role switches in dialogue (including gesture) as fluent core data, all functioning to optimise interaction
- Utterance understanding and planning as incremental predictive processes
- Dialogue processing as a highly coordinated subpropositional activity
- Structure, content, context, intentions, speech acts all mutate and evolve
- Mindreading not a pre-requisite for successful communication
- Language acquisition emerging through practising the processes of interaction

Outline

Bringing the DAG tracking changes, into DS core



DAG models partial trees (nodes), licensed actions (edges), and words (higher-level edges over triggered actions)

Sato 2011, Eshghi et al 2015, 2017 Purver & Hough 2014, Hough 2015, Howes & Eshghi 2021

With incremental setting out and recording of action potentials, system allows prediction and repair via local back-tracking to first compatible point in path:

(13) The yell- uh purple square. Brennan & Schober 2001

Manifestness of words/affixes ensures actions become affordances (solicitations) within the immediate environment. Gibson 1979, **Rietveld et al 2018, Gregoromichelaki et al 2020**. They also manifestly guide adjustment of actions, corrections, boundaries hence transitions, and emergent structure

Outline

what is the nature of grammar: the view from DS-TTR

DS-TTR: blend of DS and TTR

[Purver et al, 2010, Eshghi et al 2012, Hough 2015, Hough & Purver 2017, Gregoromichelaki 2018, Gregoromichelaki et al 2020]

grammatical/metaphysical ontology of **processes**

rather than *representations*

incrementality, **underspecification**, and **predictivity**

as properties of grammar in general,
not just a genre-specific grammar for dialogue

domain-general processes for multimodal interaction

[**in DS as led by Eleni Gregoromichelaki: Gregoromichelaki 2010, 2018, Gregoromichelaki et al 2020**]

DS-TTR syntactic mechanisms

What DS offers TTR

- (inter)actions are all you need to talk about "syntax"
- **syntactic structure over words** (tree-structures) is at best epiphenomenal
- **no separate syntactic or morpho-syntactic level of representation**:
  * no syntactic categories for strings of words;
  * no phrase-structure rules;
  * sequences of words are not sequences of symbols but sequences of **affordance triggers** (Rietveld et al)
  * putative universals can only be cognition-general constraints
- **grammatical affordances** are dynamic regularities extending over multiple time-steps

What the marriage of TTR and DS offers

What TTR offers DS as tools:

- a well-understood basis for implementation,

  richer vocabulary for logical forms as record types Purver et al 2010
- richer notion of dialogue context, augmenting DAG to model backchannels, clarifications, corrections, extensions, as all of them function to optimise emergent coordination

  Purver et al 2010, Eshghi et al 2015, Hough 2015, Howes and Eshghi 2021
- incremental specification of content Purver et al 2011
- models of DS grammar learning Eshghi et al 2013, Eshghi and Lemon 2014
- models for learning dialogue systems from data Eshghi et al 2017
- modelling indirect implications via (guided) resolution of mismatched affordances Breitholtz & Howes 2020, Howes et al in preparation
- modelling humour in mismatch-resolving terms Maraev et al 2020, 2021
- the promise of a multi-modal DS-TTR Gregoromichelaki et al 2020

Revisiting the Bickhard challenge: DS-TTR a case study

The emergence of DS-TTR as a model of language as process

Actions, coordination, and context-dependency are central

(i) manifest modal/predictive anticipation driving coordination - *DS requirements*

(ii) incremental context-dependent moment-by-moment update - *DS actions*

(iii) defining concepts of *locality* as *constraints on process*

(iv) coordination an immediate consequence of action perspective- *the split-utterance success*

(v) no essential mindreading for underpinning interaction - *not essential given manifestness of words*

(vi) error recognition/correction is expressible through the model of the shifting options at each stage - *the incorporation of DAG*

(vii) capturing lexical content as nondeterministic? - *nondeterminism potentially all the way*

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But does this impose the need for a psychologistic mind-internal explanation or an externalist social explanation ?

The cognitive basis of language in social terms

Unit of analysis: a group-based **distributed cognitive system**.

Landscape of collective affordances defines what is available.

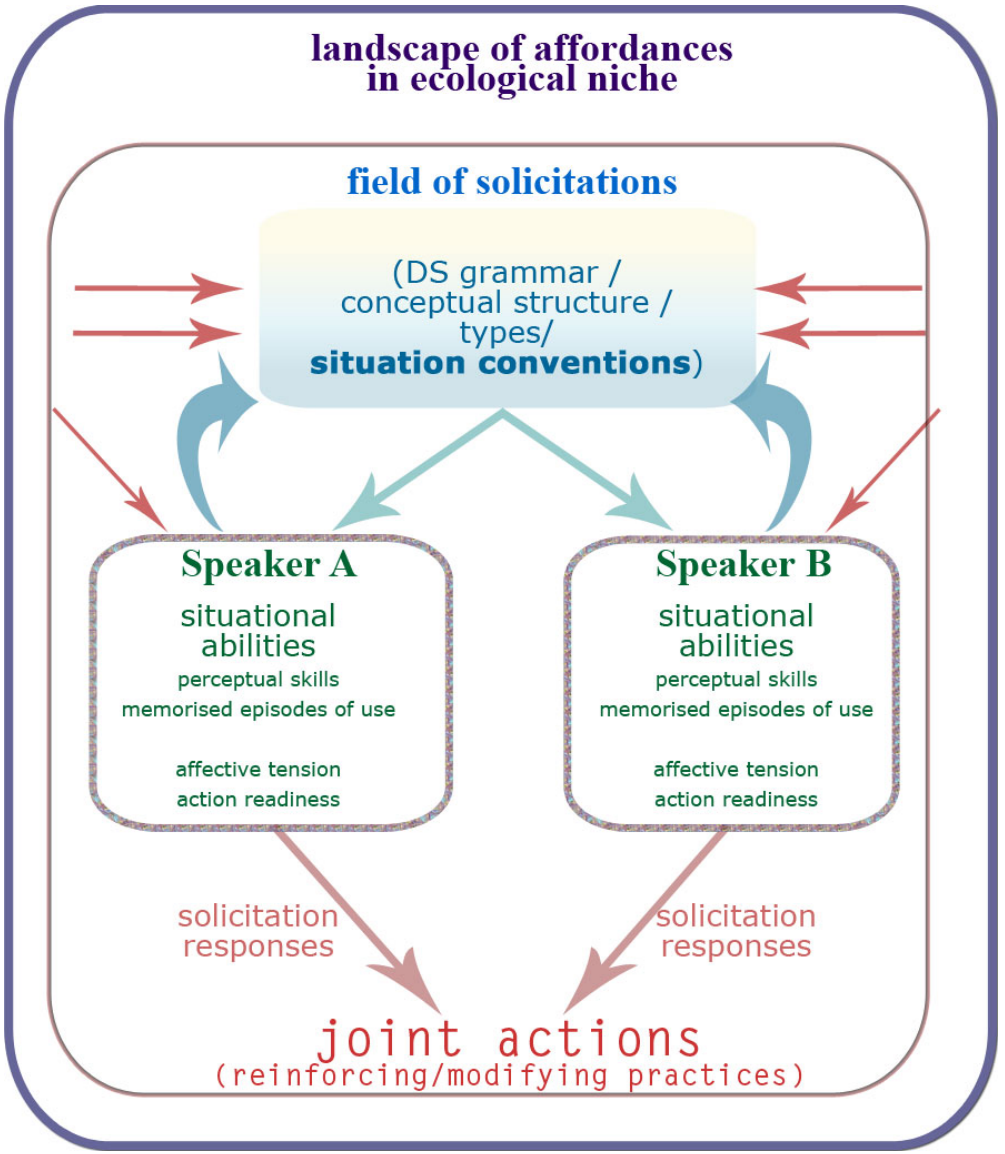
[*Skilled Intentionality* framework, Rietveld et al 2018

In **joint action**, participants' abilities, the sociomaterial environment, and the previous history of interactions codetermine a particular subset of the **field of affordances** ('solicitations').

So-called *common ground* is a property of the relation between individual participants' affordances.

DS incrementality ensures such fields are **redefined** and **transformed** with each utterance (verbal or otherwise), i.e. **situation conventions** [Bickhard, 1987] are operated on at each step

The system is in flux all the time.



interaction first and foremost

Actions (procedural 'know-how'):

These are the the basis for syntax/morpho-syntax/semantics/pragmatics

Interactions:

Both comprehension and production modelled together in the same space

Syntactic, morphosyntactic and meaning procedures:

All are formulated as (probabilistic) **transitions** from states to states

[Sato 2011, Eshghi & Lemon 2014,Hough & Purver 2014, 2017]

- with LOFT at its heart, DS defines a specialised **Propositional Dynamic Logic** with states as ⟨NL string, context⟩ and transition operators modelling basic actions and macros (packages) of such actions [Kempson et al. 2001]
- With Dynamic Logics having the means to model any type of action/event, a multimodal grammar definition for DS-TTR is a seamless extension of DS [Gregoromichelaki 2018, Gregoromichelaki et al 2020]

On the Social Nature of Normativity

- Normativity is emergent from the grammar being defined as goal-directed processes at the social level
  * An **action** is successful if either it has achieved its goal or it has contributed towards getting closer to that goal
- The purpose of language is to coordinate **joint action**:
  * A language-based action is successful if either it has achieved some goal or contributed towards possibly others doing so
- Thus a grammar as a model of such actions is now :
  * NOT an intermediary between comprehension and production, all three independently defined,
  * NOT a psychological competence of the individual independent of others.
  * NOT a model of knowledge of an individual competence independent of all other faculties and cognitive activities
- **A grammar is a model of what underpins participants' interactions in social exchange**, building on what is available in context as affordances, either giving rise to feedback leading to modification, or inducing update, possibly by others [Wittgenstein 1953, Weichold & Thonhauser 2019]

What DS-TTR enables

* Holistic view of **grammar** as guiding (production) or characterising (comprehension) behaviours

  via distributed knowledge of joint sensorimotor contingencies [Noë, 2012, 2015] without necessarily building internal models of the world

* Incremental and predictive architecture and integration of **multimodal action/perception** within a single formal model [Eshghi, et al 2017, Eshghi & Lemon 2014]

* Grounded **symbolic** representations as distributively **emergent** during interactions from basic action/interaction substratum hence a basis for language acquisition [cf Bickhard, in prep]

* Pragmatic implications modelled as *topoi* to reflect their emergent incrementality Breitholtz et al 2017 Breitholtz and Howes 2020

* Word meaning background: **Vector Space** models as exemplar theories of conceptualisation to capture nondeterminism of content [Gregoromichelaki et al 2019, Purver et al. 2021]

Outline

The relevance of the polysemy challenge

Polysemy is a systemic, language-universal phenomenon Partee 2018, Carston 2019, Recanati 2019

* *burn*: burning one's finger (lighting a match), one's back (from failing to use suncream), one's hair, the kitchen, the house, the hay, one's local forest, the Amazon forest, Greece, Australia
* *lose*: losing keys, the dog, position in a queue, a competition, heart

..

The need to address the challenge with a process semantics:

(i) polysemy as ambiguity fails to address the issue altogether;
(ii) polysemy as disjunction a compromise not able to address the many unclear cases;
(iii) In DS, it is a hang-over of Fodorian outset, to be abandoned

Why capturing polysemy is so important

- Nondeterminism of semantic content ensures
  - (i) fluent dialogue exchanges despite mismatching individual abilities,
  - (ii) shifting affordances (*solicitations*) within individual speaker/exchange,
  - (iii) stability across varying affordances,
  - (iv) effective group creation without requiring matching content,
  - (v) rounding out the view of language as a tool for building and guiding shifting affordances for interaction
  - (vi) completing the cut off from encodingism

Exploring a Distributional Semantics with DS

The spirit of Firth's contextualism with an incremental twist

- Word meanings captured statistically as word similarities across vast data sets Piedeleu et al 2015

The DS construal: Gathering collocations from vast data sets is a working analogue for modelling words as **public resources** triggering selected affordances from within the vast array of affordances available to agents

- The aim of the ongoing project is to define a concept of probabilistic incremental compositionality for a Dynamic Syntax grammar with a vector-based semantics, assessing different methods for modelling incremental context-based resolution. Purver et al 2021

Cross-disciplinary explorations buttressing DS-TTR

- **(Psycho)-linguistic evidence**, lots of it, that information-structure concepts central to language modelling [Gildea and Jaeger 2016 ...]
- **Cognitive-psychology**, empirical evidence that emergent cognitive development builds on interactivity
  [Tomasello 2019, Rączaszek-Leonardi et al. 2018, Mirski and Gut 2018]
- **Language acquisition** grounded in interaction, also a wealth of evidence
  [Arnon et al 2014, Heyes 2018, Rączaszek-Leonardi and Deacon 2018, Mirski & Bickhard 2019, 2021]
- **Skilled Intentionality Framework** for balance between cognition-internal constraints and structure of the temporal/spatial environment: [Rietveld et al, 2018, Bruineberg & Rietveld 2019...]
- **Interactivism** as the general framework for exploring the foundations of cognition and sociality [Bickhard 2009, in prep, Mirski et al 2020]

How successful is our search to escape encodingism

The game of "Hunt the Hidden Chocolate Easter Egg"?

(A) All those who stipulate levels of structure with discrete mappings from level to level (HPSG, Minimalism, LFG) FAIL

(B) All those who recognize the significance of context-dependence without framework change COLD

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(C) Creating a multimodal model to reflect dialogue dynamics and radical context-dependence GETTING WARMER

(i) Cooper et al TTR: a generalised notion of type, AVM format allowing for underspecification, defining probabilistic-rule base. TTR retains algorithmic commitment, and a static syntax base

(ii) Larsson, Dobnik et al: Defining gameboard, differentiating public/private gameboard, intensions as classifiers expressing nondeterminism, integrating perception, gesture, language processing. The syntax challenge remains open. Dobnik et al 2021

How radical do we need to be for success?

(iii) Ginzburg et al: Ginzburg 2012 Ginzburg and Poesio 2016, Ginzburg et al 2019
"Keeping the baby but in a very large bath"
Extending HPSG-TTR to give comprehensive multi-modal rule-based coverage of all potential differentiations algorithmically definable. But the underlying syntax is static, competence/ performance retained though with boundaries shifted, and ambiguity challenge is unresolved. GETTING WARMER

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NB The Easter game is "Encourage each other but finally enjoy your own egg!"

Prospects for the future, and many thanks

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This suggests a new challenge:

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So a huge thanks to everyone I've worked with over the years

Thank you for listening: I wish I were in Potsdam with you.

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