# How Dynamic Syntax emerged as a model of language as action: an evolving narrative

Ruth Kempson ruth.kempson@kcl.ac.uk

and

Eleni Gregoromichelaki, eleni.gregoromichelaki@gu.se

Thanks to Dov Gabbay, Wilfried Meyer-Viol, Ronnie Cann, Pat Healey, Matthew Purver, Christine Howes, Arash Eshghi, Julian Hough, Mehrnoosh Sadrzadeh, Gijs Wijnholds, Stergios Chatzikyriakidis, among others

#### https://www.Dynamicsyntax.org

Prologue: Accepting the Bickhard challenge to linguists Step 1: The outset: DS as a model of the understanding process Step 2: Realising that concept of NL grammar has to change Step 3: Language as incremental, context-relative processing Step 4: Modelling ongoing shifting choices incl. error correction Step 5: Testing against real data in context: dialogue modelling Step 6: Testing against multiple languages: universal constraints? Step 7: Final escape from encodingism? Explaining NL polysemy Step 8: Multimodal grammar with DS-TTR Step 9: Language as interaction Conclusions

2/49

イロト 不得 トイヨト イヨト 二日

#### Prologue: Accepting the Bickhard challenge to linguists

#### The Bickhard challenge to linguists

(Bickhard, M. 2020 (ms) The Whole person: Towards a Naturalism of Persons)

Cognitive psychology (and linguistics) are 100 years out of date

- The code model of language of fixed rules assigning fixed values to strings ("encodingism") has to be abandoned
- Nondeterminism, process, and interaction have to be basic
- Explaining cognition and its emergence requires:
  - (i) adaptation via differentiation and (modal) anticipation
  - (ii) interaction in context, as essential to adaptation,
  - (iii) coordination relative to local context,
  - (iv) representation and individuation emergent, not primitive
  - (v) capacity to recognise and correct errors essential to learning
  - (vi) no inbuilt condition of mindreading

- Actions, coordination, and context-dependency are central
  - (i) modal anticipation driving coordination
  - (ii) incremental context-dependent moment-by-moment update
  - (iii) defining concepts of locality
  - (iv) interaction an immediate consequence of action perspective
  - (v) error recognition/correction is expressible through the model of the shifting options at each stage
  - (vi) no essential mindreading for underpinning interaction
  - (vii) capturing lexical content as nondeterministic?
    - \* meeting the challenge of systemic "ambiguity"

## Outline

#### Prologue: Accepting the Bickhard challenge to linguists

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

## Modelling interpretation process for Relevance Theory

- ▶ initial goal of Dynamic Syntax (DS) was pragmatic
  - underspecification + update assumed to be at its core
  - Initial objective: Labelled Type Deduction (LDS Gabbay 1996) as model of input and enrichment process in understanding
    - (i) labels express contraints on content, and procedural constraints, type deduction over low types
  - Formal specification of Dynamic Syntax
    - (ii) epsilon calculus as logic of labels epsilon calculus is the logic of arbitrary names of predicate logic proof procedure

(epsilon term is a witness of the accumulating content)

- (iii) Logic of Finite Trees as basis for defining tree growth (LOFT) Blackburn & Meyer-Viol 1994
- revised objective: to model incrementally goal-driven process of constructing tree-representations of content
- result: a dynamic model of LF construction process
- The first surprise: solving syntactic and semantic puzzles

< ロ > < 同 > < 回 > < 回 > < 回 > <

## Outline

Step 2: Realising that concept of NL grammar has to change

The dynamics of how interpretation incrementally builds up provided natural procedure-based solutions across the board:

- (i) Puzzles for syntacticians:
  - left-right asymmetries and word-order effects in general, relative clause and cleft structure construals (Japanese, Korean, Greek, Rangi, Bantu, Chinese)
- (ii) Historical and Variational Puzzles for morphologists:
  - diachronic word-order changes (Spanish clitics); clitic clustering (Greek dialects); Bantu variability
- (iii) Puzzles for semanticists:
  - anaphora and ellipsis heterogeneity, quantifier/tense interactions

All conventional solutions involved positing multiple ambiguity and ad-hoc construction-specific stipulations

What has to be abandoned:

- old-style grammar sentence structure inhabited by words
- encapsulated domain specificity of syntax
- competence performance distinction
- To be replaced by:
  - grammar-defined actions used by speaker and hearer
  - driving word-by-word update of structure/information
  - relative to ever-changing context
- The second surprise:
  - direct explanation of dialogue exchange interactivity, the sole data for language-acquiring child, inexpressible in all conventional frameworks

イロト 不得 トイヨト イヨト

- Sentence structure emerges across agents without overall planning
- (1) Alex (mum): We're going to

Hugh (dad): to Burbage, to see Ann, Auntie Ann

Eliot (son): with the dogs?

Hugh (dad): if you take care of them.

(2) Therapist : Your sponsor before..

Client: was a woman

Therapist: Yeah

Client: but I only called her every three months

Therapist: and so your sobriety now, in AA [is]

Client: [is] at a year

[Ferrara 1002]

# Dialogue coordination: challenges for linguists

- ► Agents switch roles across ALL morpho/syntactic/semantic dependencies:
  - \* local anaphor dependency
    - (3) 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" )

- (4) A: Which unit are we thinking we should  $\ldots$ 
  - B: axe?/\*axed? None.
- \* across island constraint (debarring movement out of "island")
  - (5) A: And they ignored the conspirators who were
    - B: Geoff Hoon and Patricia Hewitt [BBC Radio4 06/09/10]
- \* quantifier variable dependency
  - (6) A: Has every gymnast handed in her
    - B: blood sample?
    - A: or even any saliva kits?
- \* determiner noun dependency
  - (7) Home-owner: I shall need a a
    - Gardener: mattock, for breaking up clods of earth. [BNC]
  - (8) Carer: Old McDonald had a farm... On that farm he had a ... Child: cow/\*cows.

# No prior specific proposition/goal/speech-act needed for communicative success: interaction essential

Interruptions/clarifications before intended proposition fixed:

- (9) 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]

There may not be a fully determined proposition anticipated

(10) A: Covent Garden?

B: Right at the lights. Then straight on up

Content and intentions may develop through dialogue interaction:

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

Speech acts may evolve via interaction:

- (12) Lawyer: Will you have your son as the executor of your will or your Client: wife, well partner.
- (13) Nursery teacher: And your name is ... Child : Mary

イロト イヨト イヨト

э

- Clarifications, corrections, role switches in dialogue are fluent core data, all functioning to optimise interaction: not performance dysfluency
- Both utterance understanding and utterance planning are incremental
- Dialogue processing is 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 emerges through interaction

Step 3: Language as incremental, context-relative processing

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

Goal-driven context-dependent actions for parsing and production induce/linearise content and word-sequences Kempson et al 2016, 2017





Tn(0) root node. Noun phrases type *e* epsilon terms; propositions type *t*; ?Ty(t) proposition as required goal.  $S_{PAST}$  event term  $Ty(e_s)$ ; predicates  $e \rightarrow (e_s \rightarrow t)$ ; Binary branching tree growth defined by modal tree logic (functor on right branch) Blackburn & Meyer-Viol 1984;  $\diamond$  is current node.

#### Language for Trees and Dynamics of Growth

#### Logic of Finite Trees: Blackburn & Meyer-Viol 1994

from the point of view of treenode n, Tn(n):

- $\langle \downarrow_0 \rangle X$  X holds at argument daughter of Tn(n).
- $\langle \downarrow_1 \rangle X$  X holds at functor daughter of Tn(n).
- $\langle \uparrow \rangle X$  X holds at mother of Tn(n).
- $\langle \downarrow_* \rangle X$  Tn(n) dominates X. ["Somewhere below is X"]
- $\langle \uparrow_* \rangle X$  Tn(n) is dominated by X. ["Somewhere above is X"]

**Requirements**: ?X for any X. All underspecifications have requirements anticipating update:

#### Underspecifications of content eg for anaphora:

- PRONOUNS **U** : Ty(e),  $\exists x Fo(x)$  [**U** a metavariable]
- WH-WORDS WH : Ty(e) [WH a specialised metavariable]
- Underspecification of structure (replacing movement) constructing a node characterised solely as "unfixed": (↑<sub>\*</sub>) Tn(a), ?Ty(e), ?∃xTn(x)

イロト 不同 トイヨト イヨト

э

## Procedures for tree development: actions all the way

Computational and Lexical Actions are conditional, defined in a tree building language with predicates make(), go(), put(): make( $\langle \downarrow_0 \rangle$ ), go( $\langle \downarrow_0 \rangle$ )put(?Ty(e))

#### Underspecified structural relations:

The outset: building an "unfixed" node as an early construction step

$Tn(a), \dots ?Ty(t),$	IF	?Ty(t), Tn(a)	
	THEN	IF	$\langle \downarrow \rangle \langle \downarrow_* \rangle \top$
I		THEN	Abort
1		ELSE	$make(\langle \downarrow_* \rangle); go(\langle \downarrow_* \rangle);$
			$put(\langle \uparrow_* \rangle Tn(a), ?Ty(e),$
$\langle \uparrow_* \rangle Tn(a)$			$\exists x Tn(x)$
$Tv(e), ?\exists xTn(x), \diamond$	ELSE	Abort	

Lexical actions also induce structure (Kempson et al 2001, Cann et al 2005, i.a)

lost IF Tn(a), ?Ty(t)THEN  $\langle \downarrow_* \rangle \top$ IF THEN  $go(\langle \downarrow_* \rangle); put(\langle \uparrow_0 \rangle \langle \uparrow_1 \rangle Tn(0))$  $go(\langle \uparrow^* \rangle Tn(a))$  $make(\langle \downarrow_0 \rangle) : go(\langle \downarrow_0 \rangle);$  $put(Ty(e_s), Fo(s_{PAST}), ?\exists xFo(x)); go(\langle \uparrow_0 \rangle)$ make( $\langle \downarrow_1 \rangle$ ); go( $\langle \downarrow_1 \rangle$ ); put(?Ty( $e_s \rightarrow t$ ));  $make(\langle \downarrow_0 \rangle); go(\langle \downarrow_0 \rangle; put(?Ty(e)); go(\langle \uparrow_0 \rangle);$ make( $\langle \downarrow_1 \rangle$ ); go( $\langle \downarrow_1 \rangle$ ); put(?  $Ty(e \rightarrow (e_s \rightarrow t))$ );  $make(\langle \downarrow_0 \rangle); go(\langle \downarrow_0 \rangle); put(?Ty(e)); go(\langle \uparrow_0 \rangle)$  $make(\langle \downarrow_1 \rangle); go(\langle \downarrow_1 \rangle);$  $put(Fo(Lose'), Ty(e \rightarrow (e \rightarrow ((e_s \rightarrow t)))))$ 

Kempson and Gregoromichelaki

### Inter-play between lexical- and tree development actions



The action language induces building of (underspecified) formula decorations, (underspecified) node relations, assigning/compiling decorations, triggered by requirements imposing constraints on update hence **anticipations** 

Compound structures (relative clauses, coordination..) are incrementally projected as independent"linked" trees, sharing an itemised common term

< ロ > < 同 > < 三 > < 三 >

### Outline

Step 4: Modelling ongoing shifting choices incl. error correction

#### Interaction Control State tracks all changes, in DS core



- ICT models parsing/generation states: partial trees (nodes), licensed actions (edges), and words (higher-level edges over triggered actions)
- Word triggers ensure access to affordances for action provided by immediate environment Gibson 1979, Rietveld et al 2018, Gregoromichelaki et al 2020 Affixes (and other actions) also guide adjustment of actions, indicate corrections, boundaries etc making transitions also an affordance.
- As incremental setting out of action potentials, ICT allows prediction and repair via local back-tracking to first compatible point in path:
   (13) The yell- uh purple square.Brennan and Schober 2001

Sato 2011, Eshghi et al 2013, 2015, Purver and Hough 2014, Hough 2015. Eshghi et al 2017 👘

### Outline

Step 5: Testing against real data in context: dialogue modelling

#### Split utterances: interactive structure building in context



The process of uttering/comprehending generates differentiation of further common action affordances, so

both parties are following the same construction process

Interaction directly achieved without mind reading, even speech act shift.

Kempson and Gregoromichelaki

Interactivism in Perspective, 25.06.21

### Outline

Step 6: Testing against multiple languages: universal constraints?

# A putative syntactic universal?

- LOFT Constraint on structure differentiation:
- Only one unfixed node of a type at a time in construction process
- (15) \*Who which editor to Mary introduced?
  - **Counter-example?** Verb-final languages as putative counterexamples: NPs in any order, so can't be assigned position until the verb is processed.
  - Resolution: Case suffixes induce the necessary immediate updating of an initially "locally unfixed node" to the position the suffix locally determines. Kempson & Kiaer 2010, Seraku 2013

supai-ni

watasita

Japanese

(16) syorui-o zyaaranisuto-ga document-овы journalist-suвы

document-OBJ journalist-SUBJ spy-DAT gave The journalist gave the document to the spy

Further puzzle that paired fronted NPs can be distant from embedded verb but these must be resolved within the same local domain: **Resolution:** predicted since building unfixed node as platform can be input to building locally unfixed nodes

#### (17)

syorui-o supai-ni keisatu-ga zyaaranisuto-ga watasita koohyoo-sita document spy-DAT police-subj journalist-subj gave reported The police reported that the journalist gave the document to the spy  $\ge$  0 < 0

Kempson and Gregoromichelaki

Interactivism in Perspective, 25.06.21

# Functional underpinning of universal constraints

- Confirmation from morphosyntax: Idiosyncratic preverbal
  "clitic-clusters" in Romance languages echo the constraint, precluding clitic sequences which underspecify their construal:
- (19) \*Marie me lui a donné

French

The pattern of free word order languages displaying rigid agreement ordering is very widespread (Romance, Greek, Bantu)

 Explanation: a diachronic freezing of interweaving structural and pragmatic options in source language via routinisation into lexically defined clusters precludes sequences which never occurred (Bouzouita & Chatzikyriakidis 2009, Chatzikyriakidis & Kempson 2011, Kempson et al 2013)

**Functional Underpinning:** The 'no reiteration' of building an unfixed node is an intrinsic constraint. All tree construction processes are nontrivial updates, so in principle re-iteration of one and the same transition without further differentiation is impossible.

イロト イヨト イヨト

### Outline

Step 7: Final escape from encodingism? Explaining NL polysemy

- The polysemy challenge, polysemy as 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
  - \* *lose*: losing keys, the dog, position in a queue, a competition, heart, one's nerve, way, concentration, ..
- Addressing the challenge with a procedural semantics:

Vector Space Semantics (VSS):

- \* vector a pointer plus direction across multi-dimensions
- \* word meaning as a range of applicability Sadrzadeh et al 2018

#### "You shall know the meaning of a word by the company it keeps"

- Distributional Semantics: items with similar distributions have similar meanings.
- Meanings of words captured statistically by assessing similarities between words from 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 (sets of) affordances from within the vast array of affordances available to agents

- each word assigned a vector, which by comparison to other words can express the space within which its uses occur
- word vectors can then be composed by a number of vector operations to yield meanings of phrases

イロト イヨト イヨト

э

- 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
  - $(\mathsf{vi})$  completing the cut off from encodingism

イロト 不得 トイヨト イヨト

### Outline

Step 8: Multimodal grammar with DS-TTR

< ロ > < 同 > < 三 > < 三 >

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

#### **DS-TTR**: blend of DS and TTR

- grammatical/metaphysical ontology of processes
  - rather than representations

★ ∃ ► < ∃ ►</p>

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

#### **DS-TTR**: blend of DS and TTR

- grammatical/metaphysical ontology of processes
  - rather than representations

★ ∃ ► < ∃ ►</p>

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

- **DS-TTR**: blend of DS and TTR
- grammatical/metaphysical ontology of processes
  - rather than representations
- domain-general processes for multimodal interaction
- incrementality, underspecification, and predictivity as properties of the grammar

A B M A B M

#### DS-TTR: syntactic mechanisms

Dynamic Syntax (DS)

イロト イボト イヨト イヨト

2

#### DS-TTR: syntactic mechanisms

#### Dynamic Syntax (DS)

(inter)actions are all you need to talk about "syntax"
#### DS-TTR: syntactic mechanisms

- Dynamic Syntax (DS)
  - (inter)actions are all you need to talk about "syntax"
- syntactic structure over words (tree-structures) is at best epiphenomenal
- no separate 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

#### DS-TTR: syntactic mechanisms

- Dynamic Syntax (DS)
  - (inter)actions are all you need to talk about "syntax"
- syntactic structure over words (tree-structures) is at best epiphenomenal
- no separate 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

 grammatical affordances are dynamic regularities extending over multiple time-steps

■ TTR [see e.g. Cooper 2012, in prep ]: linking grammar to perception and conceptualisation [cf. Barwise & Perry 1983, Barwise, & Seligman 1997, Gibson 2015 ]

- TTR [see e.g. Cooper 2012, in prep]: linking grammar to perception and conceptualisation [cf. Barwise & Perry 1983, Barwise, & Seligman 1997, Gibson 2015]
  twose (concepts) as (sets of) affordances is
- types (concepts) as (sets of) affordances [Gregoromichelaki et al 2019, 2020]

- TTR [see e.g. Cooper 2012, in prep ]: linking grammar to perception and conceptualisation [cf. Barwise & Perry 1983, Barwise, & Seligman 1997, Gibson 2015 ]
- types (concepts) as (sets of) affordances [Gregoromichelaki et al 2019, 2020]
  - affordances are the possibilities for interaction in the sociomaterial environment to which agents are "attuned"
  - interaction with entities
    - agents can interact with aspects of entities without necessarily recognising the entity
    - learning affordances ('sensorimotor contingencies') replaces the effort of building ontologies and writing rules

イロト イヨト イヨト

- TTR [see e.g. Cooper 2012, in prep ]: linking grammar to perception and conceptualisation [cf. Barwise & Perry 1983, Barwise, & Seligman 1997, Gibson 2015 ]
- types (concepts) as (sets of) affordances [Gregoromichelaki et al 2019, 2020]
  - affordances are the possibilities for interaction in the sociomaterial environment to which agents are "attuned"
  - interaction with entities
    - agents can interact with aspects of entities without necessarily recognising the entity
    - learning affordances ('sensorimotor contingencies') replaces the effort of building ontologies and writing rules
- types (concepts) as time-extended processes (*policies* accrued via Reinforcement Learning)
  - DS incrementality, temporality

イロト イヨト イヨト

- TTR [see e.g. Cooper 2012, in prep ]: linking grammar to perception and conceptualisation [cf. Barwise & Perry 1983, Barwise, & Seligman 1997, Gibson 2015 ]
- types (concepts) as (sets of) affordances [Gregoromichelaki et al 2019, 2020]
  - affordances are the possibilities for interaction in the sociomaterial environment to which agents are "attuned"
  - interaction with entities
    - agents can interact with aspects of entities without necessarily recognising the entity
    - learning affordances ('sensorimotor contingencies') replaces the effort of building ontologies and writing rules
- types (concepts) as time-extended processes (*policies* accrued via Reinforcement Learning)
  - DS incrementality, temporality
- types induce predictions for
  - what is to be encountered as perceptual stimulation next or
  - predictions regarding how the agent can interact with some entity/feature of the environment

イロト イヨト イヨト

- TTR [see e.g. Cooper 2012, in prep ]: linking grammar to perception and conceptualisation [cf. Barwise & Perry 1983, Barwise, & Seligman 1997, Gibson 2015 ]
- types (concepts) as (sets of) affordances [Gregoromichelaki et al 2019, 2020]
  - affordances are the possibilities for interaction in the sociomaterial environment to which agents are "attuned"
  - interaction with entities
    - agents can interact with aspects of entities without necessarily recognising the entity
    - learning affordances ('sensorimotor contingencies') replaces the effort of building ontologies and writing rules
- types (concepts) as time-extended processes (*policies* accrued via Reinforcement Learning)
  - DS incrementality, temporality
- types induce **predictions** for
  - what is to be encountered as perceptual stimulation next or
  - predictions regarding how the agent can interact with some entity/feature of the environment
- at each time-step, affordances need to be **selected** from a landscape of possible affordances

Kempson and Gregoromichelaki

Interactivism in Perspective, 25.06.21

### Outline

Step 9: Language as interaction

#### Conclusions

< ロ > < 同 > < 三 > < 三 >

unit of analysis: a group-based distributed cognitive system

イロト 不得 トイヨト イヨト

- unit of analysis: a group-based distributed cognitive system
- landscape of collective affordances defines what is available [Skilled Intentionality framework, Rietveld et al, 2018]

- 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')

< 同 > < 三 > < 三 >

- 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 of individual participants' affordances

< 同 > < 三 > < 三 >

- 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 of individual participants' affordances
- DS incrementality means that such fields are redefined and transformed with each utterance (verbal or otherwise), i.e., situation conventions [Bickhard, 1987] are operated upon at each step



 actions (procedural 'know-how') the basis for syntax/semantics/pragmatics

イロト イヨト イヨト イヨト

- actions (procedural 'know-how') the basis for syntax/semantics/pragmatics
- interactions: both comprehension and production modelled together in the same space

- actions (procedural 'know-how') the basis for syntax/semantics/pragmatics
- interactions: both comprehension and production modelled together in the same space
- syntactic or meaning procedures formulated as (probabilistic) transitions from states to states [Sato 2011, Eshghi & Lemon 2014]

- actions (procedural 'know-how') the basis for syntax/semantics/pragmatics
- interactions: both comprehension and production modelled together in the same space
- syntactic or meaning procedures formulated as (probabilistic) transitions from states to states [Sato 2011, Eshghi & Lemon 2014]
  - a specialised Propositional Dynamic Logic (PDL) with states as (NL string, context) and transition operators modelling basic actions and macros (packages) of such actions [Kempson et al. 2001]

- actions (procedural 'know-how') the basis for syntax/semantics/pragmatics
- interactions: both comprehension and production modelled together in the same space
- syntactic or meaning procedures formulated as (probabilistic) transitions from states to states [Sato 2011, Eshghi & Lemon 2014]
  - a specialised Propositional Dynamic Logic (PDL) with states as (NL string, context) and transition operators modelling basic actions and macros (packages) of such actions [Kempson et al. 2001]
  - Dynamic Logics have the means to model any type of action and event (physical, instrumental, epistemic, etc.)<sub>[e.g. Segerberg,</sub> 1992]: hence multimodal grammar definitions are seamless

(red path indicates the selected course of action)

?make<sub>A,B</sub>(TTR-type)

(red path indicates the selected course of action)



э

< E

э

Kempson and Gregoromichelaki

(red path indicates the selected course of action)



Alice to Bob: "Flopsy!"

< E

3 x 3

Kempson and Gregoromichelaki

Interactivism in Perspective, 25.06.21

(red path indicates the selected course of action)



Alice to Bob: "Flopsy!"

< E

3 x 3

(red path indicates the selected course of action)



Alice to Bob: "Flopsy!"

< E

3 x 3

(red path indicates the selected course of action)



Kempson and Gregoromichelaki

(red path indicates the selected course of action)



Kempson and Gregoromichelaki

(red path indicates the selected course of action)



(red path indicates the selected course of action)



(red path indicates the selected course of action)



Kempson and Gregoromichelaki

## Outline

#### Conclusions

< ロ > < 同 > < 三 > < 三 >

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

- 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

- 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 ]

- 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 [cf Bickhard, in prep]

- 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 [cf Bickhard, in prep]
- word meaning background: Vector Space models conceived as exemplar theories of conceptualisation [Sadrzadeh et al. 2018, 2021,

Gregoromichelaki et al 2019, Purver et al. 2021]

イロト イヨト イヨト

### DS: what do cross-disciplinary explorations buy us?

- Evidence buttressing Dynamic Syntax as an interaction tool
  - Cognitive psychology empirical evidence that emergent cognitive development builds on interactivity [Tomasello 2019, Raczaszek-Leonardi et al. 2018, Mirski and Gut 2018]

Language acquisition grounded in interaction [Arnon et al 2014, Heyes 2018, Raczaszek-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, cf. Mirski et al 2020]
- **Interactivism** as providing the general framework within which we can explore the foundations of cognition and sociality

[Bickhard 2009, in prep, Mirski et al 2020]

イロト 不得 トイヨト イヨト
# Points for discussion

- DS is a 'distributed cognition' framework [Hutchins, 1995] rather than an "autonomous cognitions interacting" model
  - cognitive processes are relations between an agent and other systems

# Points for discussion

- DS is a 'distributed cognition' framework [Hutchins, 1995] rather than an "autonomous cognitions interacting" model
  - cognitive processes are relations between an agent and other systems
- both Interactivists and DS inspired by Ecological Psychology initially by J. J. Gibson and E. J. Gibson
  - who developed an interactionist view of perception/action focusing on information available in the environment
    - rather than internal "enrichments" of stimuli
  - who focused on active online and temporally-extended "differentiation", rather than passive, brain-internally stored representations
  - thereby rejecting the standard fragmentation of processes as external-physical vs internal-mental

イロト イヨト イヨト

 Parallels between DS and Interactivism (modulo the more externalist DS orientation)

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions

イロト 不得 トイヨト イヨト

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions
    - no frame problems [Bickhard 2001, in prep]
    - variation and selection epistemology/problem-solving/ontologies [Bickhard & Campbell 2003, Bickhard in prep]

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions
    - no frame problems [Bickhard 2001, in prep]
    - variation and selection epistemology/problem-solving/ontologies [Bickhard & Campbell 2003, Bickhard in prep]
  - utterances as action-macros/operators on fields of affordances
    - / situation conventions
      - emergent social normativity

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions
    - no frame problems [Bickhard 2001, in prep]
    - variation and selection epistemology/problem-solving/ontologies [Bickhard & Campbell 2003, Bickhard in prep]
  - utterances as action-macros/operators on fields of affordances / situation conventions
    - emergent social normativity
  - anticipatory, predictive articulation of courses of actions

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions
    - no frame problems [Bickhard 2001, in prep]
    - variation and selection epistemology/problem-solving/ontologies [Bickhard & Campbell 2003, Bickhard in prep]
  - utterances as action-macros/operators on fields of affordances / situation conventions
    - emergent social normativity
  - anticipatory, predictive articulation of courses of actions
  - states of action readiness / emotion and values, rather than rational motivations / mindreading

イロト イヨト イヨト

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions
    - no frame problems [Bickhard 2001, in prep]
    - variation and selection epistemology/problem-solving/ontologies [Bickhard & Campbell 2003, Bickhard in prep]
  - utterances as action-macros/operators on fields of affordances / situation conventions
    - emergent social normativity
  - anticipatory, predictive articulation of courses of actions
  - states of action readiness / emotion and values, rather than rational motivations / mindreading
  - no factoring into syntax, semantics, pragmatics

イロト 不得 トイヨト イヨト

- Parallels between DS and Interactivism (modulo the more externalist DS orientation)
  - fundamentality of processual ontology
  - emergent notion of representations and symbolic/encoding signs
  - DS constraint-based framework parallels implicit presupposition of background conditions
    - no frame problems [Bickhard 2001, in prep]
    - variation and selection epistemology/problem-solving/ontologies [Bickhard & Campbell 2003, Bickhard in prep]
  - utterances as action-macros/operators on fields of affordances / situation conventions
    - emergent social normativity
  - anticipatory, predictive articulation of courses of actions
  - states of action readiness / emotion and values, rather than rational motivations / mindreading
  - no factoring into syntax, semantics, pragmatics
  - coordination rather than communication [??]

# Points for discussion: interactivist aporias :)

Interactivists ask:

イロト 不得 トイヨト イヨト

### Points for discussion: interactivist aporias :)

#### Interactivists ask:

but how do you jump the 'epistemic boundary'? [Bickhard 2009, in prep]

イロト 不得 トイヨト イヨト

- but how do you jump the 'epistemic boundary'? [Bickhard 2009, in prep]
  - the epistemic boundary is an artifact and remnant of the representationalist and substance assumptions and attendant methodological tendencies of "generalising to the worst case" [cf. disjunctivism, McDowell 1982]

イロト 不得 トイヨト イヨト

- but how do you jump the 'epistemic boundary'? [Bickhard 2009, in prep]
  - the epistemic boundary is an artifact and remnant of the representationalist and substance assumptions and attendant methodological tendencies of "generalising to the worst case" [cf. disjunctivism, McDowell 1982]
  - processual frameworks have enough resources to account for coordination (rather than epistemological coincidence) without foundational internalist "rerepresentations"

- but how do you jump the 'epistemic boundary'? [Bickhard 2009, in prep]
  - the epistemic boundary is an artifact and remnant of the representationalist and substance assumptions and attendant methodological tendencies of "generalising to the worst case" [cf. disjunctivism, McDowell 1982]
  - processual frameworks have enough resources to account for coordination (rather than epistemological coincidence) without foundational internalist "rerepresentations"
- but how do you account for agent-detected error and learning/adaptivity? [Bickhard 2009, in prep]

- but how do you jump the 'epistemic boundary'? [Bickhard 2009, in prep]
  - the epistemic boundary is an artifact and remnant of the representationalist and substance assumptions and attendant methodological tendencies of "generalising to the worst case" [cf. disjunctivism, McDowell 1982]
  - processual frameworks have enough resources to account for coordination (rather than epistemological coincidence) without foundational internalist "rerepresentations"
- but how do you account for agent-detected error and learning/adaptivity? [Bickhard 2009, in prep]
  - via attunement, the 'education of attention' [Gibson 2014, Gibson & Gibson 1955], which is, in fact, what 'differentiation' implicates but in externalist terms

イロト イヨト イヨト

- but how do you jump the 'epistemic boundary'? [Bickhard 2009, in prep]
  - the epistemic boundary is an artifact and remnant of the representationalist and substance assumptions and attendant methodological tendencies of "generalising to the worst case" [cf. disjunctivism, McDowell 1982]
  - processual frameworks have enough resources to account for coordination (rather than epistemological coincidence) without foundational internalist "rerepresentations"
- but how do you account for agent-detected error and learning/adaptivity? [Bickhard 2009, in prep]
  - via attunement, the 'education of attention' [Gibson 2014, Gibson & Gibson 1955], which is, in fact, what 'differentiation' implicates but in externalist terms
  - evolutionary and cultural structuring of ecological niche [e.g. Heft, 1989]

イロト イヨト イヨト

# Thank you for your attention!

Interactivism in Perspective, 25.06.21

イロト イボト イヨト イヨト

2

### Selected references (also www.Dynamicsyntax.org) I

Arnon, I. et al (eds) 2014. Language in Interaction: studies in honor of Eve V. Clark John Benjamins.

Barwise, J., & Perry, J. 1983. Situation and Attitudes. MIT Press.

Barwise, J., & Seligman, J. 1997. Information flow: the logic of distributed systems. Cambridge University Press.

Bickhard, M. H. 1987. The social nature of the functional nature of language. In M. Hickmann (Ed.), Social and functional approaches to language and thought (pp. 3965). Academic.

Bickhard, M. H. 2001. Why children don't have to solve the frame problems: Cognitive representations are not encodings. *Developmental Review*, 21(2), 224-262.

Bickard. M.H. 2009 The interactivist model Synthèse 166(3):547-591

Bickard, M.H. in prep. The Whole Person: Towards a naturalism of persons, contributions towards an ontological psychology

Bickhard, M. H., & Campbell, D. T. 2003. Variations in variation and selection: The ubiquity of the variation-and-selective-retention ratchet in emergent organizational complexity. *Foundations of science*, 8(3), 215–282.

Bruineberg, J. & Rietveld. E. 2014 Self-organization, free energy minimization, and optimal grip on a field of affordances *Frontiers in Human Neuroscience*. vol.8. Article 599.

Bruineberg, J. & Rietveld, E. 2019 What's inside your head once you've figured out what your head's inside of *Ecological Psychology* 3.13, 198-217.

Carston, R. 2016 The heterogeneity of procedural meaning. Lingua 175-176, 154-166.

Carston, R. 2019. Ad hoc concepts, polysemy and the lexicon. In Scott, K. et al *Relevance, Pragmatics and Interpretation*, pp. 150-163 CUP

Cooper, R. 2012. Type theory and semantics in flux. In Ruth Kempson, Nicholas Asher, and Tim Fernando, editors, Handbook of the Philosophy of Science, volume 14: Philosophy of Linguistics, pages 271323. North Holland.

イロト イヨト イヨト

# Selected references (also www.Dynamicsyntax.org) II

Cooper, R., (in prep.) From perception to communication: An analysis of meaning and action using a theory of types with records (TTR). online draft.

Cooper, R. & J. Ginzburg. 2015. Type theory with records for natural language semantics. The Handbook of Contemporary Semantic Theory, pages 375407.

Eshghi, A. 2015 DyLan: An incremental, semantic, contextual parser for dialogue. In SEMDIAL Proceedings 2015 (GoDIAL).

Friston, K.J. 2010 The free-energy principle: a unified brain theory? Nature Reviews Neuroscience 11

Frith, C & U. Frith 2012. Mechanisms of social cognition. Annual Review of Psychology 61. 287-313

Gibson, J. J. 2014 The Ecological Approach to Visual Perception: Classic Edition. Psychology Press, New York.

Gibson, J. J., & Gibson, E. J. 1955. Perceptual learning: Differentiation or enrichment?. *Psychological review*, 62(1), 32.

Gregoromichelaki. E. 2013 Grammar as action in language and music. In M. Orwin, R. Kempson, and C. Howes, editors, *Language, Music and Interaction*, pages 93134. College Publications, London.

Gregoromichelaki. E. 2018. Quotation in dialogue. In P. Saka and M. Johnson, editors, *The Semantics and Pragmatics of Quotation*, pages 195255. Springer, Cham.

Gregoromichelaki, E & R. Kempson 2019 Procedural syntax. In K. Scott, et al eds, *Relevance: Pragmatics and Interpretation* pp.187-202 CUP.

E. Gregoromichelaki, C. Howes, A. Eshghi, R. Kempson, J. Hough, M. Sadrzadeh, M. Purver, and G. Wijnholds. 2019 Normativity, meaning plasticity, and the significance of vector space semantics. In *Proceedings of the 23rd Workshop on the Semantics and Pragmatics of Dialogue*, 2019.

H. Heft. 1989. Affordances and the body: An intentional analysis of Gibsons ecological approach to visual perception. *Journal for the Theory of Social Behaviour*, 19(1):130.

Heyes, C. 2018. Cognitive gadgets; the cultural evolution of thinking. Harvard University Press.

イロト 不同 トイヨト イヨト

э.

# Selected references (also www.Dynamicsyntax.org) III

Hough, J. 2015 Modelling Incremental Self-Repair Processing in Dialogue. Phd Thesis, Queen Mary University of London

Hough, J. & M. Purver 2014. Probabilistic type theory for incremental dialogue processing. Proceedings of EACL 2014 workshop on Type Theory and Natural Language Semantics, 80-88.

Kempson, R., Cann, R., Gregoromichelaki, E., Chatzikyriakidis, S. 2016. Language as Mechanisms for Interaction. *Theoretical Linguistics*, Volume 42, Issue 3-4, Pages 203276.

McDowell, J., 1982, Criteria, Defeasibility and Knowledge, Proceedings of the British Academy, 68: 45579.

Mirski, R., & Bickhard, M. (2019). Encodingism is not just a bad metaphor. *Behavioral and Brain Sciences*, 42, E237. doi:10.1017/S0140525X19001286

Mirski, R., & Bickhard, M. H. 2021. Conventional minds: An interactivist perspective on social cognition and its enculturation. *New Ideas in Psychology*, 62, 100856.

Mirski, R., Bickhard, M. H., Eck, D., & Gut, A. (2020). Encultured minds, not error reduction minds. *Behavioral and Brain Sciences*, 43.

Mirski, R., & Gut, A. 2018. Action-based versus cognitivist perspectives on socio-cognitive development: Culture, language and social experience within the two paradigms. *Synthese*, 1-27.

Noë, A. 2012. Varieties of Presence. Harvard University Press.

Noë, A. (2015). Concept pluralism, direct perception, and the fragility of presence. Open MIND. Frankfurt am Main: MIND Group. doi = 10.15502/9783958570597

Rietveld, E., D. Denys, and M. VanWesten. 2018 Ecological-Enactive Cognition as engaging with a field of relevant affordances. In *The Oxford Handbook of 4E Cognition*, p. 41. Oxford University Press, Oxford.

Pickering, M. & Garrod, S. 2013 An integrated theory of language production and comprehension. *Behavioral and Brain Sciences*, 36(04), 329-347.

Purver, M., Sadrzadeh, M Wijnholds, G., Kempson, R. & Hough, J. 2021. Incremental Composition in Distributional Semantics. *Journal of Logic, Language and Information* Vol 30.

イロト イポト イヨト イヨト

Rączaszek-Leonardi, J., Nomikou, I., Rohlfing, K. J., & Deacon, T. W. 2018. Language development from an ecological perspective: Ecologically valid ways to abstract symbols. *Ecological Psychology*, 30(1), 39-73.

Rączaszek-Leonardi, J., & Deacon, T. W. 2018. Ungrounding symbols in language development: implications for modeling emergent symbolic communication in artificial systems. In 2018 *Joint IEEE 8th International Conference on Development and Learning and Epigenetic Robotics* (ICDL-EpiRob) (pp. 232-237). IEEE.

Sadrazadeh, M. et al. 2021. Incremental composition in Distributional Semantics JOLLI

Sadrazadeh, M. Purver, J. Hough, R. Kempson. 2018 Exploring Semantic Incrementality with Dynamic Syntax and Vector Space Semantics. *SEMDIAL 22 Proceedings*, 122-132.

Segerberg, K. 1992. Getting started: Beginnings in the logic of action. Studia logica, 51(3-4):347378.

Tomasello, Michael 2019 Becoming Human: A Theory of Ontogeny Harvard.

Weeds J. et al 2014 Learning to distinguish hypernyms and co-hyponyms Proceedings of COLING 24.

Wilson, Deirdre 2016. Re-assessing the conceptual-procedural distinction. Lingua 175-6, 5-19.