Completability vs (In)completeness

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ABSTRACT

In everyday conversation, no notion of "complete sentence" is required for
syntactic licensing. However, so-called "fragmentary", "incomplete", and aban-
doned utterances are problematic for standard formalisms. When contextualised,
such data show that (a) non-sentential utterances are adequate to underpin
agent coordination, while (b) all linguistic dependencies can be systematically
distributed across participants and turns. Standard models have problems
accounting for such data because their notions of 'constituency' and 'syntactic
domain' are independent of performance considerations. Concomitantly, we
argue that no notion of "full proposition" or encoded speech act is necessary
for successful interaction: strings, contents, and joint actions emerge in conversa-
tion without any single participant having envisaged in advance the outcome of
their own or their interlocutors' actions. Nonetheless, morphosyntactic and
semantic licensing mechanisms need to apply incrementally and subsententially.
We argue that, while a representational level of abstract syntax, divorced from
conceptual structure and physical action, impedes natural accounts of subsen-
tential coordination phenomena, a view of grammar as a "skill" employing
domain-general mechanisms, rather than fixed form-meaning mappings, is
needed instead. We provide a sketch of a predictive and incremental architecture
(Dynamic Syntax) within which underspecification and time-relative update of
meanings and utterances constitute the sole concept of "syntax".

KEYWORDS Dynamic syntax; ellipsis; fragments; incrementality; joint action; repair; split utterances;
English; Modern Greek

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1. Introduction

In this paper we take the view that natural language (NL) is first and foremost coordinative joint action. We take utterances as primarily causal physical events having effects (as stimuli) on human agents. As such, they can be characterised as *actions* realising goals distributed across agents and induced *incrementally*, i.e., their realisation is extended over time intervals (Kempson, Meyer-Viol, and Gabbay 2001). The distributed physical behaviours and cognitive actions that control NL-related behaviours we take to constitute the *grammar*. From this perspective, it is actions (modelled by *procedures*) that constitute grammar, perception, and cognition, rather than internal representations, symbols, or constructions (Gregoromichelaki and Kempson 2019; Gregoromichelaki, Kempson, and Howes 2020). NL stimuli also have historical provenances linking processing episodes over longer stretches of time over which words come to trigger whole sequences of actions through routinisation and normalisation of such sequences (Kempson, Gregoromichelaki, and Howes 2019; Bouzouita and Chatzikyriakidis 2009). Such past sources account for some of the current effects of such stimuli allowing them to operate as constraints on the dynamics of an unfolding task towards some intended or unforeseen joint outcome (Gregoromichelaki et al. 2011). For this reason, memory traces and dispositions are the individual mechanisms grounding NL use driving the grammar to evolve often imperceptibly through intermediate stages which we might call "ad hoc grammars". At each interaction instance, such grammars effect the tightly interwoven integration of NL stimuli within joint activities that require moment-by-moment coordination among interlocutors and the environment.

1.1. NL grammar as action coordination

Starting from this perspective, our dynamic approach to NL maintains that what is important for grammar modelling is the time-involving and inter-active properties of an NL system, whereas internal static formal structures like symbols, syntactic categories, or 'constructions' are epiphenomenal abstractions over the flow of coordination dynamics (see also Hopper 2011). As evidence, we take the fact that, given data from everyday joint activities, no representational notion of "complete sentence", or even 'syn-tactic constituent', is required for explaining NL use (Bergs 2017; Gregoromichelaki et al. 2009, 2011; Kempson et al. 2017a, 2016, 2017b). In fact, we have argued, and argue further below, that such notions impede natural characterisations of how NL elements contribute to the achievement of agent coordination (see, e.g. Gregoromichelaki 2013b; Gregoromichelaki et al. 2013). Despite claims to the contrary, the data indicate unambiguously that non-sentential utterances constitute complete and apposite

contributions enabling participants in context to seamlessly achieve effective conversational interaction:

(1) Eleni: You are not leaving, are you?
    Frank: End of the month.

Moreover, empirical research shows that utterances of various lengths and types are learned and used throughout the individual's lifespan, always embedded within interactional activities with the environment or other agents. Children learn to control their behaviour in order to interact long before they begin to perceive or use NL actions (Fotopoulou and Tsakiris 2017). Consequently, when various types of utterances are first used they complement existing mechanisms for interaction, e.g. turn-taking (Clark and Casillas 2016; Hilbrink, Gattis, and Levinson 2015). These NL stimuli manipulated within interactions then acquire an open-ended variety of functions as procedures specifically and flexibly adapted to the achievement of coordination. In our view, this can be accomplished because NL procedures are not just means for exploiting the 'context', but, crucially, triggers for unfolding further socially-enabled action opportunities (*affordances*): affordances create context (aka "common ground"), rather than rely on a pre-existing one, as they direct joint attention by highlighting precisely the significance of particular features of the situation *both* for oneself and one's interlocutors.

1.2. *Joint action and the meaning of non-sentential utterances*

Jointly exploring and newly interpreting the context in this way is achieved because NL affordances selectively activate socially-grounded dispositions, which, when combined with individual capacities (see, e.g. Bruineberg, Chemero, and Rietveld 2019), shape an ever-shifting domain-general ad hoc conceptual grammar biasing perception and action by evoking previous experiences with the current NL signal. Public reemployment and recognition of a signal thus set out interpretive possibilities of selected aspects of the current experience (i.e., *conceptualisation*) so that various *joint-projects* (Clark 1996) can be pursued. Such joint-projects (or language-games, Eshghi and Lemon 2014, Eshghi and Lemon 2017) can then be achieved by use of even minimal NL contributions (e.g., *Huh?* in (2)) without the need to characterise these as "elliptical" and requiring syntactic or denotational expansion to turn them into what is supposed to constitute their true though covert natural-language sentence-form.[1] Instead, we assume that NL use is subsumed under various forms of "procedural coordination" (Mills 2011,

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[1]Hence our use of the term *nonsentential utterance* rather than *fragment* with its suggestion of being intrinsically incomplete.

2014; Mills and Gregoromichelaki 2010). Under this perspective, the requisite complementarity of individual actions that enable distributed conceptualisations within language games can be fulfilled by nonsentential utterance triggers, rather than NL propositional contents. This is because such triggers come embedded within interactional routines, ((3), turn 2), structured by the complementarity afforded by the temporal sequentiality of turn-taking and the emerging joint agency that shapes the structure of the game as it is carried out:

(2) 1 A: How would'ja like to go to a movie later on tonight?
2 B: Huh?=
3 A: **A movie** y'know like **a like … a flick?**
4 B: Yeah I uh know what a movie is (.8) It's just **that**=
5 A: **you don't know me well enough?** [from Sacks (n.d.)]

(3) 1 A: I'm pretty sure that **the**:
2 B: **programmed visits**?
3 A: programmed visits, yes, I think they'll have been debt inspections. [BNC]

Given the methodology of modelling incrementality and joint agency via an emergent interaction grammar distributed across the participants engaged in the "game", any lexical action undertaken can be seen as potentially complete, having effects in its own right. On the other hand, and equally importantly, lexical actions serve as a trigger for further processing by being perceived as constraints shaping the unfolding wider action context. Wellformedness and "grammaticality" are thus ratified moment-by-moment in context by the participants, rather than being absolutely predefined via some abstract generative mental device. In this way, the local adaptive dynamics of co-action impose an overall structuring in language-games of various scales under which role differentiation and joint responsibility (*action complementarity*) can be induced and sustained without explicit cognitive and/or public representations of what the agents seek to accomplish. For example, agents – just by taking advantage of incremental processing – can produce, or induce their interlocutor to provide, the input required to complete their own actions, thus actualising ad hoc the performance of what have been described as conventional *adjacency pairs* or speech acts (Gregoromichelaki, Cann, and Kempson 2013; Mills and Gregoromichelaki 2010):

(4) 1 Jane: u:m Professor Worth **said that**, if Miss Pink runs into difficulties, on Monday afternoon, with the standing subcommittee, over the item on Miss Panoff,
2 Kate: **Miss Panoff?**

3 Jane: yes, **that Professor Worth would be with Mr Miles all after-noon**, - so she only had to go round and collect him if she needed him [from Clark (1996): 240-241]

(5) Angus: But Domenica Cyril is an intelligent and entirely well-behaved dog **who**

Domenica: **happens** to smell [BBC radio 4 play, 44 Scotland Street][2]

With grammars conceived not as primarily underpinning individual processing but joint action, any type of syntactic or semantic dependency can be set up and resolved across more than one turn with the resolving element satisfying expectations generated by either interlocutor. By shifting the focus of NL analysis away from the denotational or referential function of NL strings to their procedural and dynamic potential, we can then observe that what have been characterised as purely syntactic dependencies can adequately operate as speech-act triggers implementing complementarity of action across participants:

(6) Jack: I just returned
Kathy: from …
Jack: Finland. [Lerner (2004): 162]

(7) Psychologist: And your so your sobriety now, in AA::[(is)]
Client: [is] at a year [Ferrara (1992): 221]

1.3. Syntax as state transitions

However, shifting the view of syntax to be seen as constituted by a set of procedures complementary to all other actions in dialogue, instead of the encoding of independent static structure, does not mean that we deny its significance. Even though complete sentences or clauses are not necessary for dialogue processing, morphosyntactic and semantic constraints are implicated in the incremental continuity of discourse and the choice and licensing of non-sentential utterances. For example, in English and other languages, the obligatory binding of a reflexive pronoun can be distributed over turns uttered by distinct interlocutors shifting its form in accordance with contextual parameters that subsententially switch as they track the current speaker and addressee roles:

(8) {A emerging from a smoking kitchen}
A: I've burnt the kitchen rather badly.
B: Have **you** burnt

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[2]Along with our own collected natural data (where no sources are provided), constructed data from literature, film scripts etc. are particularly relevant as they show that such constructions cannot be dismissed as "speech errors" or "performance accidents" that can be easily excluded from theoretical considerations.

A: **Myself**? No.

Moreover, in morphologically-rich languages, nonsentential speech acts, e.g., a reproof by means of an apparent clarification in (9a-b), require the presence of appropriate "agreement" morphemes, e.g. case, gender, indicating how the uttered "fragment" is to fit in the distributed conceptualisation of the context triggered by the utterance:

(9) Modern Greek
   [Context: A is contemplating the space under the mirror while re-
      arranging the furniture and B brings her a chair]

a. A to B:	tin	karékla	tis	mamás?	(íse	trelí?)
	DEF:ACC	chair[ACC]	DEF:GEN	mum:GEN	(be:2SG	crazy)
	'Mum's chair?	(are you crazy?)'				

b. A to B:	#i	karékla	tis	mamás?	(íse	trelí?)
	#DEF.NOM	chair[NOM]	DEF:GEN	mum:GEN	(be:2SG	crazy?)
	'Mum's chair?	(are you crazy?)'				

From a dynamic perspective, such "morphosyntactic" constraints are not arbitrary checking features or parasitic on some referential function of the phrases involved. Instead, these constraints themselves are a constitutive part of the set of situated affordances attributed by participants to the entity involved, for example, the potential of an old chair to serve as part of the furniture suitable for an entrance hall. Perceiving and inducing this set of context-relative affordances (which is the most basic notion of how an 'entity' becomes differentiated in context, Bickhard (2009)) is achieved via the amalgamation of stimuli in the environment with NL stimuli indicating their afforded 'conceptualisation'. Hence use of particular morphosyntactic forms allows a range of particular functions to be associated with features of the entity within the action under way, while excluding others.

1.4. *Joint achievement of meaning*

Given the seamless contribution of NL actions to the set of available multi-modal affordances, there is no need for nonsentential utterances to be semantically expanded to yield propositional contents either (contra Ginzburg 2012). In fact, such expansion does not accord with empirical evidence of how coordination proceeds. In dialogue, participants are afforded the opportunity to negotiate subsententially the construal of the lexical and phrasal items involved (see, e.g., (4), (5)) as they incrementally

process the NL signal. Thus we argue that what is needed is a grammar of NL *performance* that models NL contributions as *affordances* for interaction embedded within language games. (Gregoromichelaki 2013a, 2018; Gregoromichelaki and Kempson 2019). As parts of sequences of other actions, such affordances do not need any sentential, constructional, or propositional grounding, in fact, such expansions are bound to be inadequate given the infinite potential of NLs for innovation and creativity (Gregoromichelaki 2013b). Semantically, NL elements functioning as affordances rely on semantic/syntactic *potentials* (Larsson 2007; Norén and Linell 2007) rather than encoded referential/representational contributions. In our terms, they are triggers for anticipations of further action based on dispositions built through previous experiences with the relevant NL structures.

Under this view of NL content, incrementality underpins both production and comprehension. First, for production, incrementality means that interlocutors do not need to plan whole propositional units before they start speaking; instead, they generate multiple local (probabilistically ranked) predictions of the following perceptual inputs, i.e., anticipations of how the projected units (words, phrases, or non-verbal actions) will affect the context, which includes the interlocutors' reactions. Through a process of *affordance competition* (Cisek 2007, but as grounded in a joint-agency setting), producers then select and verbalise a minimal NL action that would ensue in the most rewarding outcome concerning the (joint) task (Cisek and Kalaska 2010). This is why speakers can unproblematically integrate gradual modifications of their utterance (e.g. repairs) induced by themselves ((2), turn 3) or their interlocutor and they can go on extending and elaborating their own utterance ((4), turn 3) or the one offered by an interlocutor ((3), turn 3). Thus, the production process is very tightly incrementally coordinated with the interlocutors' responses as it includes a feedback loop that controls all participants' actions (Goodwin 1981; Bavelas, Coates, and Johnson 2000).

In the same way, during comprehension, efficient incremental procedural coordination imposes on addressees that they too continuously predict the upcoming stimuli and check whether their own and the interlocutors' actions, as well as the actually perceived NL stimuli, conform to those. Thus addressees incrementally generate and seek the satisfaction of local predictions ranked according to reward value. They can then intervene in a timely manner where their anticipations are found in over-threshold error and some "surprising" input cannot be integrated as an unforeseen but adequately rewarding outcome. This local adjustment to task requirements via affordance competition avoids the need to impose the necessary calculation of whole propositional intentions or even implicate (a potentially infinite regress of) mutually known facts, as might be expected on a Gricean take on this interactional dynamic of utterance exchange. Experimental and empirical conversation analysis evidence shows, contrary to all such Gricean accounts, that interlocutors do not engage in complex mindreading processes trying to figure out "speaker

meaning", or need to calculate common ground (Engelhardt, Karl, and Ferreira 2006, a.o.). The reason for this is that each agent during an interaction does not act independently to realise a predefined action plan. In fact, often, no such plan exists or only emerges post hoc independently of the agents' explicit goals (hence the value of conversation). Instead, from an incremental and dynamic perspective, shared understanding proceeds via a principle of 'progressivity' (Robinson 2014; Zama and Robinson 2016; Healey et al. 2018): given the tight coordination and potential for feedback at any point, interlocutors can allow interactions to progress as though shared understanding has been achieved unless misunderstanding is overtly raised as an issue. As a result, individuals assume complementary roles locally and opportunistically attempt to figure out and direct the conceptualisation of the task itself (Suchman 1987).

1.5. Coordination as repair

To coordinate their perspectives and skills interlocutors engage in orientation actions (which we call "repair") employing the minimum of resources in order to direct the activity to their predicted reward-affording outcomes (see (4), turn 2; (3), turn 2). As Schegloff (1979) notes, overwhelmingly the most common occurrence of a repair initiation action is not after the sentence in which the problem occurs. Most commonly, the repair occurs "intrusively" without concern about the "integrity" of the sentence. Since this flexibility is relevant for any utterance in conversation, syntax needs to provide the means, we argue, incrementality, for accommodating this paramount coordination phenomenon. The flexibility provided by incremental processing also affords the advantage that interlocutors can abandon unfruitful courses of action midway (see (2), turn 3), even within a single proposition, without presupposing that such productions will be taken as having remained unprocessed:

(10) A: **Bill**$_i$, who . . ., sorry, Jill$_j$, **he**$_i$'s abroad, she$_j$ said to let me finalise the purchase.

Even though useful as a descriptive characterisation of normative practices (Schegloff 2007), from a dynamic modelling perspective, singling out a notion of "repair" for explicating the function of all such nonsententials is, in our view, misleading. We assume that any behaviour in dialogue aims to control perception (via selecting and predicting relevant feedback), with perception in turn providing the motivation for further selection of actions. From our processing perspective, repair as a separate category of constructions (Clark 1996) is an artifact of assuming that the interlocutors aim for the establishment of shared common world "representations" employing speech acts that contribute propositional contents (Poesio and Rieser 2010; Ginzburg 2012) in the service of reasoning and planning. Instead, we can see the goal of feedback control, striving

to repair 'prediction error' (Clark 2017a,b), as a constant local aim and structuring factor of any (joint) activities. These local adaptive dynamics ensue in more global organisations with the appearance of a preplanned whole even though NL grammars do not necessarily manipulate overarching notions of "complete sentence", "full proposition" or clearly demarcated speech acts. Various speech acts, potentially implementing 'pushmepullyou' functions (i.e., not differentiated as 'referential'/'descriptive' vs 'directive' (Millikan 1995)), can be accomplished while a single proposition is under way with strings, contents, and intentions emerging incrementally without any participant having envisaged in advance the global structure and outcome of the interaction (Gregoromichelaki, Cann, and Kempson 2013; Gregoromichelaki et al. 2013; Hopper 2011):

(11) Hester Collyer: It's for me.
     Mrs Elton the landlady: **And Mr. Page?**
     Hester Collyer: **is not my husband**. But I would rather you continue to
   think of me as Mrs. Page.   [The Deep Blue Sea (film)]

In these circumstances, the meanings and structure of such "fragments" are shaped during the interaction via procedural mechanisms. They are not based on encoded semantic meanings or stored form-meaning mappings ('constructions'). However, this does not preclude the assumption that normative forces constrain the action of participants in a dialogue. By being situated in a *field of affordances* (Rietveld, Denys, and Maarten 2018), in our view, the grammar, the actions of individuals have to adapt to what is possible and sanctioned as appropriate within the particular sociocultural practice they participate in. Such practices determine the available competing affordances. Within these bounds, any emergent meanings, being available affordances, are locally opportunistic, open-ended, and flexible but, nevertheless, appropriate for the situation; and, if they are not, due to incomplete adaptation to the situation, they will be challenged either synchronically or diachronically and either by oneself or by others. In order to function in this manner, as a source of situated normativity, the grammar associates NL signals with coordinative procedural instructions, operating as *constraints* on the possibilities for action, rather than as structural elements accruing referential functions. Both NL signals and their "contents" function as induced (first- and second-order) affordances shaping the horizon of choices of each co-actor during the 'affordance competition' stage of action selection (Cisek 2007). For this reason, we argue that NL grammars need to model the *mechanisms* allowing such affordance creation, perception, or modification, rather than positing stored stocks of symbols, concepts, categories, or word meanings as stable and a priori shared across individuals; and we now turn to sketching a constraint-based formalism as witness to the implementation potential of the claims we are putting forward.

2. Language as action

2.1. Dynamic syntax

Dynamic Syntax (DS, Cann, Kempson, and Marten 2005; Kempson, Meyer-Viol, and Gabbay 2001) is a grammar architecture whose core notion is incremental interpretation of word-sequences (comprehension) or linearisation of contents (production) relative to context. The DS syntactic engine, including the lexicon, is articulated in terms of goal-driven actions accomplished either by giving rise to expectations of further actions, by consuming contextual input, or by being abandoned as unviable in view of more competitive alternatives. Thus words, syntax, and morphology are all modelled as "affordances", opportunities for (inter-)action produced and recognised by interlocutors to perform step-by-step a coordinated mapping from perceivable stimuli (phonological strings) to conceptual actions or vice-versa. To illustrate, we display below the (condensed) steps involved in the parsing of a standard long-distance dependency, *Who hugged Mary?*.[3] The task starts with a set of probabilistically-weighted predicted *interaction-control states* (ICSs) represented as a directed acyclic graph (DAG) keeping track of how alternative processing paths unfold or are progressively abandoned (see also Sato 2011; Eshghi, Purver, and Hough 2013; Hough 2015)[4]

(12)
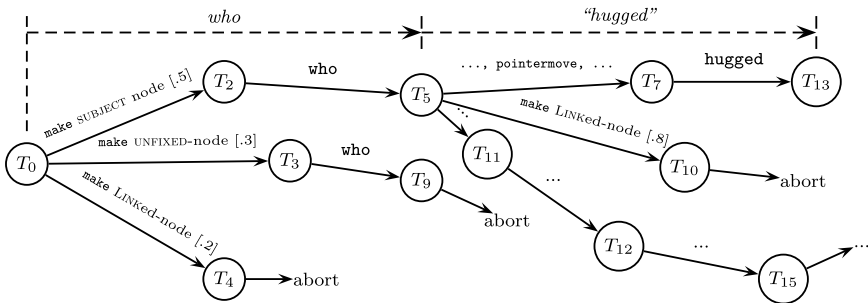
The graph displays the state space of the initial stage of the parse in a very simplified manner due to space restrictions. Even before the parse of verbal input is initiated, probabilistically weighted predictions of potential actions and their consequences further down are displayed. For example, simplistically, in English, one can start by either processing a subject, or a dislocated phrase (UNFIXED-node), or an adjunct (LINKED-node). The DS action make predictively constructs

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[3]The detailed justification of DS as a grammar formalism is given elsewhere (Kempson, Meyer-Viol, and Gabbay 2001; Kempson et al. 2016; Cann, Kempson, and Marten 2005, a.o.).
[4]In order to simplify presentation, the available macros have been significantly condensed and schematically mentioned through the more central effects they induce; ellipsis (..) indicates that multiple steps have been omitted as they have been judged as irrelevant to the point we wish to make; numbers in square brackets indicate a toy illustration of how probability distributions over macros are implemented.

nodes that cater for these possibilities with probabilities (in square brackets) associated in the ICS with the likelihood of each such action in that particular context. Words like *who* and *hugged* are then processed within that pre-established environment with the ICSs tracking salient environmental information, means of coordination, e.g. "repair" (Eshghi et al. 2015; Howes and Eshghi 2017), and the recent history of processing.

Besides actions like `make`, other DS actions introduce goals (*requirements*, shown with an initial ?) to seek linguistic or other input that licenses building or linearising conceptual structures ('ad-hoc concepts'). Goals are introduced with constraints, for example, as to what kind of content is required to be sought. This is indicated in the form of labels accompanying the requirements, for example, ontological types indicate what kind of conceptualisation is expected for any perceived input information: e stands for entities in general; e_s for eventualities; $(e \rightarrow (e_s \rightarrow t))$ stands for the type associated with what are standardly called 'one-place predicates', but here with the presumption that such predicates also induce an 'eventuality' node as an additional argument; etc.[5]

In (13) below, focussing now on only one snapshot of an active DAG path from (12) above (and only the syntactically-relevant part), we see that the initial goal (indicated by ?) is realised as a prediction to eventually process a proposition of type t. Below, this is shown as a one-node tree with the requirement $?Ty(t)$ and the ICS's current focus of attention, the pointer ◊:

(13)

$?Ty(t), ◊$ $\overset{...who...}{\longrightarrow}$ $?Ty(t)$ $\mathbf{WH} : e, ◊$
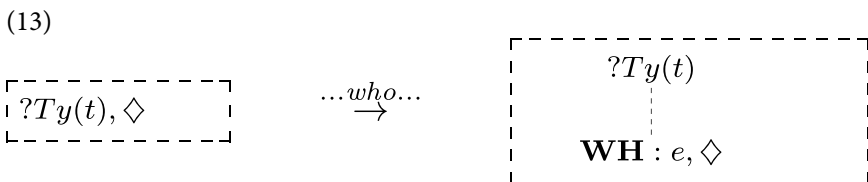
In order to achieve the satisfaction of this prediction, the next step should involve input from the interlocutor, the material environment, or by the agent themselves producing the requisite mental or physical actions. In the latter case, as here, the pointer at a node including a predicted type t outcome drives the prediction of further subgoals whose achievement is expected to eventually satisfy the current goal.

For (13), one of the probabilistically-licensed next steps for English (executed by sequential routines (*macros*) of actions) is displayed in the second partial tree: a prediction that a structurally underspecified (UNFIXED) node (indicated by the dotted line) can be built and accommodate the result of parsing or generating *who*. As illustrated here, given the loss of

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[5]With the combination of DS with Type Theory with Records (TTR) (Purver et al. 2010), the potential for much more fine-grained conceptual distinctions and ad hoc types has been introduced (see e.g. Eshghi, Purver, and Hough 2013; Hough 2015; Hough and Purver 2014; Gregoromichelaki 2018; Gregoromichelaki and Kempson 2019, a.o.).

morphological case distinctions in English, temporary radical uncertainty about the eventual contribution of some element is implemented through *structural underspecification*. Initially "unfixed" tree-nodes model the retention of the contribution of the *wh*-element in a memory buffer until it can satisfy the prediction associated with some argument node in the upcoming local domain. Grammatical words like *who* and other semantically weak elements (e.g. pronominals, anaphors, auxiliaries, tenses) contribute underspecified content in the form of *metavariables* (indicated in bold font), which trigger search for their eventual type-compatible substitution from among contextually-salient entities or predicates.

In the next steps, various macros are employed to develop a binary tree: in (14), the verb contributes conceptual structure by unfolding the tree further, and fetches an ad-hoc concept (indicated as *Hug*) developed according to contextual restrictions,[6] as well as placeholder metavariables for time and event entities ($\mathbf{S}_{PAST}$) whose values need to be supplied by the current ICS:

(14)
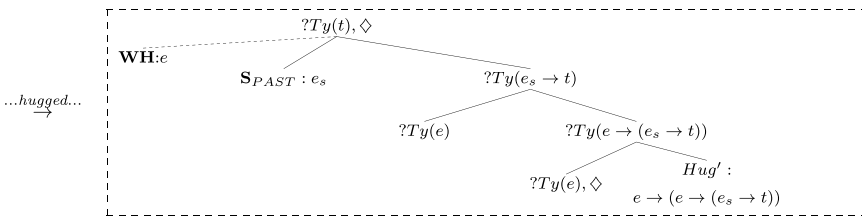
The conceptual structure being built is indefinitely extendible (Cooper 2012) and not meant as a passive inner model of the world ("non-reconstructive"; Clark 2017a). Instead, it is relational: a pairing of structures reflecting (aspects of) the world (so-called *records* modelling situations) with humanly relevant processing types (*record types*), i.e., learned response dispositions to particular stimuli.[7] Thus types function as (higher-order) affordances, i.e., labels of intermediate stages in the generation of further actions. It is the differentiation of the next actions generated that individuates the types, not their labels. To take a "syntactic" example, type t is differentiated from type $(e_s \rightarrow t)$ in that the former (minimally) leads to the prediction of a left daughter of type e_s and a right daughter of type $(e_s \rightarrow t)$ whereas the latter leads to the prediction of e and $(e \rightarrow (e_s \rightarrow t))$ (that is, minimally a predicate-argument array comprising at least one argument node over and above the event-term node). As such the types constitute subpersonal

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[6]In Purver et al. (2010), this is modelled as a *record type* using a Type Theory with Records formulation, but we suppress these details here (see also Eshghi, Purver, and Hough 2013; Hough 2015; Hough and Purver 2014; Gregoromichelaki 2018; Gregoromichelaki and Kempson 2019; Gregoromichelaki, Kempson, and Howes 2020, a.o.).

[7]In this externalist perspective, we diverge from standard construals of TTR as in Ginzburg (2012); Cooper (2016).

mechanisms, not conceptual labels, however, they can be brought to consciousness by processes of reification for e.g., explicit planning, theory construction, clarification, or teaching.

Given affordance competition, agents select their next actions based on possibilities (probabilistically) grounded on these types (which function as 'outcome indicators', Bickhard and Richie 1983) so that the types might be reinforced (verified) or abandoned (fail) in the next steps. As long as they remain live possibilities, types do not passively represent the world but keep triggering flows of predictions for further possible (mental or physical) action opportunities. These predictions, in the case of verbal dialogue, concern either participant extending or "repairing" the DAG node elements, thus coordinating behaviour with selected aspects of the environment and each other.

Returning to the processing stage in (14), we see the pointer ◊ at a predicted argument node. This implements the word-order restriction in English that the object follows the verb. In NLs with explicit morphological case, like Greek in (9a-b), it is the case morpheme instead that induces the embedding of the noun content under a particular role assignment in the emergent conceptual structure. For English, on the other hand, it is the place of the pointer at the stage shown in (14), that allows *Mary* to be processed at the sister node of the predicate *Hug'*. At this position, the lexical form triggers the tracking of a contextually-identifiable individual (*Mary'*) that is being affected by the action indicated by the verb content (for the view that such entity concepts are tracking abilities allowing the accumulation of knowledge about individuals, see Millikan 2000). After this step, everything is in place for the structural underspecification to be resolved, namely, the node annotated by *who* can now unify with the subject node of the predicate, resulting in an ICS that includes the minimal content of an utterance of *Who hugged Mary?* imposed as a goal ($?Q_{\mathbf{WH}}$) for the next action steps (either by the speaker or the hearer):
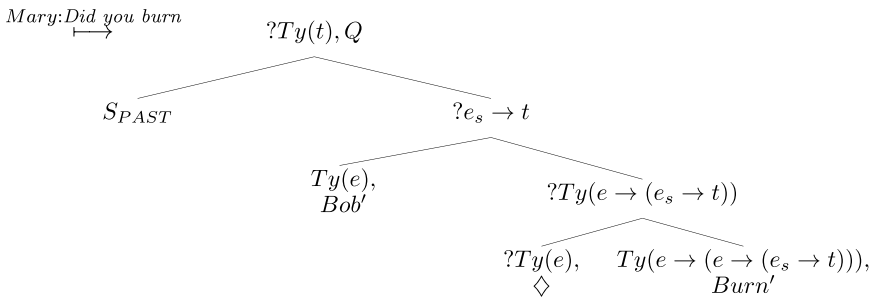
(15)
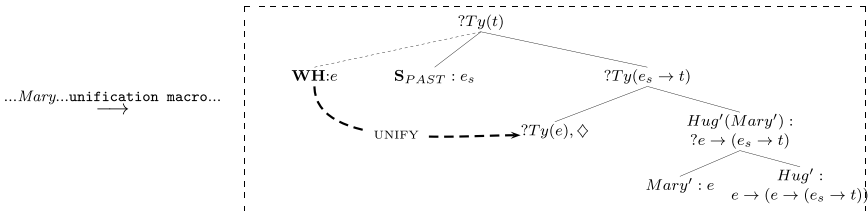
(16)
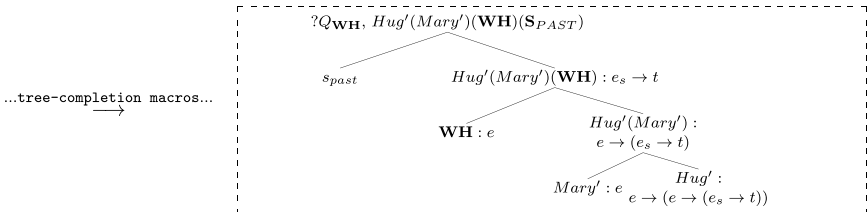
The DS model assumes tight interlinking of NL perception and action: the predictions generating the sequence of trees above are equally deployed in comprehension and production. *Comprehension* involves the generation of predictions and goals and awaiting input to satisfy them, while *production* involves the deployment of action (verbalising) by the predictor themselves in order to satisfy their predicted goals. By imposing top-down predictive and goal-directed processing at all stages of both comprehension and production, interlocutor feedback is constantly anticipated and seamlessly integrated in the ICS (Gargett et al. 2009; Gregoromichelaki et al. 2009; Purver et al. 2010; Eshghi et al. 2015). Feedback in the form of so-called "repair" is syntactically accommodated in DS with an apposition-like linking mechanism which associates incrementally either simple proposition-like structures such as (16) or, locally, structures of any type (as in e.g. adjunct processing, see (4), turn 1). Such appositions and update can be provided by either interlocutor and refer either to their own or to the other's utterance. All such operations take place within the context displayed in (12). For this reason, maintaining even abandoned options as required for the explicit modelling of conversational phenomena like (partial) repetition clarifications, self/other-corrections, etc., but also, quotation, code-switching, humorous effects, and puns (Hough 2015; Gregoromichelaki 2018) is not problematic. Moreover, given the modelling of word-by-word incrementality, there is the potential at any point for either interlocutor to take over and realise the currently predicted goals in the ICS. This can be illustrated in the sharing of the dependency constrained by the locality definitive of reflexive anaphors:

(17) Mary: Did you burn
      Bob: myself? No.

As shown in (17), Mary, the speaker, starts a query involving an indexical, *you*, which in DS terms introduces a metavariable that is resolved by reference to the CURRENT-HEARER ICS contextual parameter at present occupied by *Bob'*. Due to the actions introduced by the verb, the pointer is now at the position of the object of *Burn'*:

(18)

$Mary{:}\overset{Did\ you\ burn}{\longmapsto}$ $?Ty(t), Q$

S_{PAST} $?e_s \to t$

$Ty(e),$
Bob' $?Ty(e \to (e_s \to t))$

$?Ty(e),$ $Ty(e \to (e \to (e_s \to t))),$
$\diamondsuit$ $Burn'$

With the ICS tracking the speaker and hearer roles as they shift subsententially, these roles are reset in the next step when Bob takes over the utterance. *Myself* is then uttered. Being a pronominal, it contributes a metavariable and, being a reflexive indexical, it imposes the restriction that the entity to substitute that metavariable needs to be a co-argument that bears the CURRENT SPEAKER role. At this point in time, the only such available entity in the ICS context is again *Bob'* which is duly selected as the replacement of the metavariable:

(19)

$$\stackrel{Bob:myself?}{\longmapsto} \quad Ty(t), Q?(Burn'(Bob')(Bob')(S_{PAST})), \diamond$$

$$S_{PAST} \qquad\qquad Ty(e_s \rightarrow t), Burn'(Bob')(Bob')$$

$$Ty(e), \quad\qquad Ty(e \rightarrow (e_s \rightarrow t)), Burn'(Bob')$$
$$Bob'$$

$$Ty(e), \quad Ty(e \rightarrow (e \rightarrow (e_s \rightarrow t))),$$
$$Bob' \qquad\qquad Burn'$$
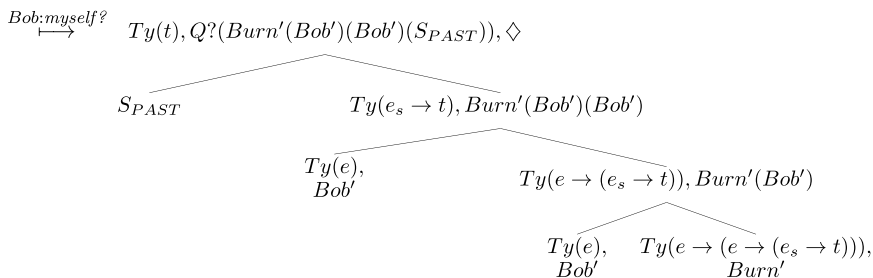
As a result, binding of the reflexive is semantically appropriate, and locality is respected even though simply joining the string as a single sentence (**Did you burn myself?*) would be ungrammatical according to any other syntactic or semantic framework thus preventing an account of such an instance of successful joint action. This successful result relies on (a) the lack of a syntactic level of representation (cf. Auer 2014), and (b) the subsentential licensing of contextual dependencies. In combination, these design features render the fact that the utterance constitutes a joint action irrelevant for the wellformedness of the sequence of actions constituting the string production. This means that coordination among interlocutors here can be seen, not as propositional inferential activity, but as the outcome of the fact that the grammar consists of a set of licensed complementary actions that speakers/hearers perform in synchrony (Gregoromichelaki et al. 2011; Gregoromichelaki, Cann, and Kempson 2013; Gregoromichelaki and Kempson 2016). Due to subsentential step-by-step licensing, speakers are not required to plan propositional units, so hearers do not need to reason about propositional intentions. Given that both parsing and production are predictive activities, a current goal in the ICS may be satisfied by a current hearer, so that it yields the retrieval or provision of conceptual information that matches satisfactorily the original speaker's goals, as in (3), (6), deflects the original speaker's action ((5)), or can be judged to require some adjustment that can be seamlessly and immediately provided by feedback extending or modifying the ensuing ICS (as in, e.g., (2), turn 5, (10)).

2.2. On the interaction of individual and social cognition in the processing of non-sentential utterances

The incremental action dynamics of DS, and its emphasis on underspecification and update for both NL resources and context specifications, reflect the formalism's fundamental mechanism of cross-modal predictivity. This allows for parsimonious modelling of NL data and accommodates now commonly accepted psycholinguistic evidence of prediction from standard sentence processing studies (Altmann and Kamide 1999; Trueswell and Tanenhaus 2005, a.o.). Further than this though, the articulation of DS as a formalism directly models current corpus-derived and experimental dialogue data. The phenomena encountered in such data, characterised as "ellipsis" or "fragments" in other frameworks, do not support the claim made in most accounts that an independent level of syntactic analysis based on sentential/phrasal units is required for licensing. In fact, as we saw earlier in (17)-(19) such a level of analysis actually impedes the characterisation of instances of successful interaction.

Neither do such data support the semantic/pragmatic assumption that it is whole propositions that are the basis of joint action and inference. For example, experimental data showing the plasticity of NL resources during interaction do not usually ensue as the outcome of sentential or propositional exchanges. In fact, explicit attempts at coordination at the sentential/propositional level with, e.g., discussion of plans/intentions impedes coordination (Mills and Gregoromichelaki 2010). Instead, without explicit negotiation, experimental participants manage to coordinate effectively by developing idiosyncratic "sublanguages" with task-specific grammars and vocabularies. For example, in the maze-task (Garrod and Anderson 1994), pairs of people collaborate to navigate through a maze, opening barriers ("gates") for each other to reach a goal point; participants have to guide each other through the maze without seeing each other or each other's maze layout. In these task-oriented dialogues, at high-levels of expertise and coordination, interaction takes the form of highly compact short utterances. Such "fragment" uses emerge gradually over time as participants progressively increase their efficiency. Efficiency lies in the fact that during their shared interaction histories, participants develop routines of coordinated physical actions with interspersed NL signals to solve the maze. Trial after trial, as they develop highly synchronised sequences of physical actions, the amount and size of NL signals decrease. Eventually, interlocutors develop highly formulaic non-sentential utterances, e.g., just pairs of numbers indicating maze coordinates, which radically condense the complex meanings that had been expressed linguistically in the initial stages of the game (Mills 2014; Mills and Gregoromichelaki 2010):

(20)

		Trial 1
8.	A:	describe your first switch
9.	B:	top left corner, the very top
…	…	…
14.	B:	wheres yours?
15.	B:	ok can u take the space 2 cubes below
16.	A:	the waht?
17.	B:	ok
18.	A:	im now stuck in the top lft corner, the gates shut
19.	B:	my switch is on the 3rd cube down from your sw, i mean on the 3rd cube down
…	…	…
38	B:	btw in in the 6 top cubes, *im
39.	A:	you see each individual square
40.	B:	yep
…	…	…

⇒

		Trial 11
1.	A:	1,2 2,6 1,4
2.	A:	5,6
3.	B:	4,5 3,4 7,1
4.	B:	1,4
5.	A:	4,5
6.	B:	1,2
7.	A:	4,5

Each pair of participants develops their own sequences reflecting idiosyncratic conceptions of the maze layout and ad hoc linguistic signals with idiosyncratic meanings. Consider Dyad 8, Trial 6: A explicitly introduces "ATG", which is subsequently recast as "AYG", to abbreviate "at [your] goal", immediately using it subsequently as a question, asking 'are you at your goal?':

(21) Dyad 8. Trial 6

1.	A:	ATG -at your goal
2.	A:	ATG?
3.	B:	huh
4.	A:	AYG -at your goal
5.	B:	no im not i need u to open my gate
6.	B:	lol
7.	B:	ok u ATG

Four trials later (Dyad 8, Trial 10), the dyad has developed a much richer system, using "AMG" to abbreviate 'At my goal', "AYS" for 'At your switch', and "GC" for 'gates clear':

(22) Dyad 8. Trial 10

1.	A:	AMG lol
2.	B:	4,1 and 3,5
3.	A:	AYS
4.	B:	nope u sure
5.	B:	GC
6.	A:	AYS
7.	B:	AMG

As shown from the transcripts (Mills 2014), the actual meaning of each such "fragment" encapsulates elaborate procedural information and instructions, disambiguated by the fragment's time-linear location within the dialogue (see, also, Knutsen, Bangerter, and Mayor 2018).

The data coming from these tasks also demonstrate that sentential integrity and "wellformedness" are a context-dependent and incrementally assessed notion. Additional evidence for this comes from other experiments exploiting the same techniques but testing for the effects of shared utterances. For example, responses to truncated turns depend on how predictable the continuation is (Howes et al. 2011, 2012). Extremely predictable continuations do not even need to be articulated by either party in order to be taken unproblematically as part of the interpretation of what has been said. On the other hand, continuations that are predictable in terms of structure but not content prompt dialogue participants to provide multi-functional utterances, merging the performance of multiple speech acts, for example, serving both as continuations, and offering feedback as clarification requests.

These empirical facts show that grammatical licensing and semantic/pragmatic processing are performed jointly subsententially online, at each step affording possibilities for further extension by the interlocutors' actions or the situational context. Taking dynamic practices of interaction as foundational, we can ground the appearance of presumed phenomena of "conventionalisation", "processing economy" (Kirby, Simon 1999; Carston 2002) or "signal economy" (Langacker 1977), evidenced by NL "fragment" use, in the plastic mechanisms of action coordination rather than stored structures and contents or burdening the inference mechanisms. But, in our view, this requires viewing NLs as "skills" implemented by domain-general procedures rather than fixed form-meaning mappings.

3. Conclusion

During interaction people constantly provide each other with ongoing feedback – they interrupt, clarify, and adapt their own and each other's linguistic and physical actions. Although this mutual responsivity is intrinsic to joint action coordination, non-sentential linguistic feedback is very difficult to account for using standard formalisms. In non-incremental models, non-sentential utterances are typically ignored as performance "errors". Alternatively, they are relegated to an extra-grammatical "performance" module, differentiating parsing and production from syntax/semantics. Such models then need to include a method of individuating "plans, goals, intentions" in combination with a probabilistic language model reflecting experience with language use (Kobele 2016). In an incremental integrative

formalism like DS, on the other hand, non-sentential linguistic input/output and "repair" mechanisms, as well as shared or abandoned utterances are not modelled as a problem for the interlocutors or the grammar. A DS grammar formalises normative mechanisms as affordances operating during joint action and constraining the dynamics of processing. Given that the landscape of affordances is constantly changing, interactants continually aim to build upon partial chunks of information and extendable sequences of actions. Partiality, rather than completeness, is thus basic for all forms of human interaction, which is constantly in progress and whose purpose is to modify the interlocutors' cognitive, social, and physical environments, a key feature for learning and adaptation purposes.

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