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Agentive Cognitive Construction Grammar: a predictive semiotic theory of mind and language

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Abstract: This paper introduces a novel perspective on *Agentive Cognitive Construction Grammar* (AgCCxG) by examining the intricate interplay between mind and language through the lens of both Active Inference and Peircean semiotics. AgCCxG emphasizes the impact of intention and purpose on linguistic choices as a cognitive imperative to balance the *symbolic Self* (Intelligent Agent) with the dynamics of the environment. Among other things, the paper posits that linguistic constructions, particularly Constructional Attachment Patterns (CAPs), like argument structure constructions, embody experienced interactions with the world through reenactment routines via the integration of multisensory channels. Unlike traditional usage-based approaches (e.g., construction grammars), AgCCxG embraces a robust theory of signs that reveals human representation as a continuous process of semiotic hybridization for the creative prediction of uncertain scenarios. Importantly, the paper challenges the notion of the mind as a unified, rational, uncertainty-reducing machine by asserting that physical processes governing open biological systems profoundly influence the linguistic sign system. Intelligent agents' adaptability in expressing incongruous realities thus highlights the role of semiotic hybridization in preserving an agent's autonomy and semiotic boundary.

Keywords: active inference; *Agentive Cognitive Construction Grammar*; constructional attachment patterns; free energy; intelligent agency; predictive semiotics

1 Introduction

1.1 *Agentive Cognitive Construction Grammar*: a predictive semiotic theory of mind and language

Since their inception by Fillmore et al. (1988), construction grammars have struggled to position themselves as an explanatory and ontologically consistent field of endeavor (construction grammar not being a real "linguistic theory" as some wrongly

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claim [e.g. Cappelle 2024]) that opposes the Chomskyan paradigm in linguistics. However, it is currently accepted that, apart from some appealing descriptions of linguistic idiosyncrasy (Brisard 2023), construction grammars have failed to provide a cogent picture of language and language use beyond some questionable reductions of linguistic representation to statistical learning (e.g., Goldberg 2019). This has led to paucity in the formulation of ideas that account for the cognitive status of constructions (Silvennoinen 2023), which currently remain a purely speculative construct (Samuel 2020), especially in areas in which the postulation of constructions, using the conceptual tools available to construction grammar, are incapable of supporting strong claims (a case in point being the reduction of modal meaning to corpus-identified formulas, in an attempt to reduce explanatory complexity, e.g., Depraetere et al. 2023). Moreover, the lack of unifying theoretical bases among constructionists has led to the formulation of unmotivated "principles" (e.g., Leclercq and Morin 2023) inspired by an outdated Popperian idea of theory postulation/falsifiability whereby language is reduced to physics and linguistic constructions are given a psychological status on the basis of hyper-controlled variable-reducing psycholinguistic experiments (e.g., Cappelle 2024).

This paper presents a fresh revision of *Agentive Cognitive Construction Grammar* (AgCCxG, Torres-Martínez 2018a, 2018b, 2019, 2020, 2021a, 2021b, 2022a, 2022b, 2022c, 2023a, 2023b, 2023c), a theory focused on the interplay between mind and language that emphasizes the impact of intention and purpose on linguistic choices. Its cognitive nature arises from recognizing that linguistic selections are driven by the imperative of biological open systems to maintain equilibrium between a symbolic Self and the dynamics of the environment (see Torres-Martínez accepted), since "[a]gents have a *different ontological status* than physical objects because they do not just exist, but exist for their internal purpose" (Sharov 2018: 213). In contrast to usage-based approaches, AgCCxG relies on a robust theory of signs that describes human representation as an ongoing process of semiotic hybridization aimed at reducing uncertainty. This implies that agents, by definition, are creative cognizers, capable of predicting highly incongruent scenarios in which generative models, like those posited by Predictive Processing (theories of the predictive brain, e.g., Clark 2015; Hohwy 2013), often fall short in providing a coherent analysis of human representation.

According to AgCCxG, predictive agents are not confined to an information-weighing representational box but can extend their representational reach, thanks to their ability to employ various types of heuristics (see Torres-Martínez 2023d). For example, in the possibility of creating fictional worlds and characters, cognizers make use of, among others, *displacement*, that is, the "the ability to talk and think about other things than those in our immediate environment" (Maier and Stokke 2021: 1). To press the argument further, one could add that the state of beliefs of a cognizer is most likely *fragmented*, that is, that the mind is not unified. The traditional unified view of the mind entails, as Kindermann and Onofri (2021) put it, "a unified representation of the world (at time *t*) – a single state of belief organized by two

principles: 1. *Consistency*: The total set of an agent's beliefs (at *t*) is consistent; 2. *Closure*: The total set of an agent's beliefs (at *t*) is logically closed. That is, agents believe the logical consequences of their beliefs."

In this view, the idealization of cognizers as rational, uncertainty-reducing machines seems to be a necessary condition for the existence of "intelligent agents." However, AgCCxG defends a fundamental principle in the understanding of language as a semiotic system, namely, that the physical processes governing open biological systems have a profound influence on the linguistic sign system. Therefore, the possibility of manipulating language to express incongruous realities brings to the fore the adaptability of intelligent agents as a means to create the conditions for preserving autonomy and semiotic boundary while striving to attain a preferred future. As we will see, there is no need to postulate an "Enlightened Room Problem (ERP) of predictive processing," that is, the definition of the exact mechanisms by which "a predictive system [struggles] to seek out anything that is truly 'different from what it already knows'" (Constant et al. 2023: 2). The reason is that biological systems are symbols[1] defined by specific interactive routines and anomalies with the environment that presuppose continuous sign hybridization. Sign hybridization represents a form of *epistemic impurism*, whereby truth-conducive factors "do not exhaust the set of conditions that determine whether a true belief qualifies as knowledge. Rather, in addition, the subject's practical situation plays an important role too" (Blome-Tillman 2022: 105).

1.2 AgCCxG as a predictive semiotic theory: active inference and Peirce

Traditionally, semiotics has characterized language as a process of symbolic representation governed by reference and convention, in the belief that its normative use delineates language's role as a distinct sign system. In contrast, AgCCxG, as a predictive semiotic theory, raises a crucial query: if language operates as an adaptive semiotic system composed of constructions, how do these constructions fulfill a cognitive purpose? The response posits that language, as an integral component of a biological system, establishes a connection between the organism's imperative to

1 This means that a species has a role within an eco-niche that creates identifiable patterns of behavior. The animal sign is thus an all-encompassing characterization of organisms as agents possessing intentionality. On this reading, agents "include humans, animals, plants, single-cell organisms, individual cells in multicellular organisms, families, colonies, populations, ecological consortia, human communities, businesses and nations, autonomous mechanisms, robots, functional protein complexes in cells, viruses, and modified or engineered organisms" (Sharov and Tønnessen 2021: 4).

navigate uncertainty, maintain inner-body homeostasis, and engage in intentional, goal-oriented actions in the world.

This perspective aligns with *Active Inference* (AIF), a process theory embraced by various disciplines (e.g., *computational neuroscience*, Friston 2005, 2010; *Predictive Processing*, e.g., Clark 2013; or mathematical frameworks like the *Free-Energy Principle*, Friston 2010, 2019). AIF formalizes perception as the inference of the world's state based on sensory data through the minimization of variational free energy (cf. Torres-Martínez 2023a, 2023b, 2023c, 2023d). One key aspect of AIF is the idea that living organisms must employ statistical predictions of the world's state to reduce entropy (systemic disarray leading to collapse), enabling them to effectively manage *surprise* (free energy).

In the context of AIF, homeostatic integrity is only possible when an organism is capable of detecting and reducing the effect of environmental distortion; differently put, when the organism actually knows that its internal states are in tune with external conditions affecting their action on the world. On this view, a *statistical boundary* (*Markov blanket*, Friston 2010; Pearl 1988),[2] interfaces incoming signals through dedicated receptors providing the system with information regarding system-external conditions. *Perceptual surprise* is thus a fundamental element in the evolution of the species, since it is the degree of acquaintance with the unknown what guarantees our survival.

The AIF model involves a set of equations that describe how the agent's beliefs and actions are updated over time. Some basic equations capture the basic principles of the model (See Smith et al. 2022 for a full discussion). Note that this version of the equations assumes a discrete time step and a discrete state space.

1. *Generative model of the environment:*
   $p(y\_t|x\_t)$ – the likelihood of sensory input y_t given hidden environmental state x_t $p(x\_t|x\_\{t-1\}, u\_\{t-1\})$ – the transition probability of environmental state x_t given previous state $x\_\{t-1\}$ and previous action $u\_\{t-1\}$
2. *Generative model of the agent's internal states:*
   $p(y\_t|z\_t)$ – the likelihood of sensory input y_t given hidden internal state z_t $p(z\_t|z\_\{t-1\}, u\_\{t-1\})$ – the transition probability of internal state z_t given previous state $z\_\{t-1\}$ and previous action $u\_\{t-1\}$
3. *Belief updating using variational inference:*
   $q(x\_t)$ – the agent's approximate posterior distribution over environmental state x_t $q(z\_t)$ – the agent's approximate posterior distribution over internal state z_t. The agent's beliefs are updated using the following equations:

2 A Markov blanket offers a useful metaphor for the division between system internal/external states, as well as active and sensory states.

$$q(x\_t) \sim \exp\left(E\_\{z\_t\}\left[\log p\left(y\_t \mid x\_t\right) + \log p\left(x\_t \mid x\_\{t-1\}, u\_\{t-1\}\right)\right.\right.$$
$$\left.\left. + \log q\left(x\_\{t-1\}\right)\right]\right) q(z\_t) \sim \exp\left(E\_\{z\_\{t-1\}\}\left[\log p\left(y\_t \mid z\_t\right)\right.\right.$$
$$\left.\left. + \log p\left(z\_t \mid z\_\{t-1\}, u\_\{t-1\}\right) + \log q\left(z\_\{t-1\}\right)\right]\right)$$

where $E\_\{z\_t\}[.]$ denotes the expected value with respect to the distribution $q(z\_t)$ and $E\_\{z\_\{t-1\}\}[.]$ denotes the expected value with respect to the distribution $q(z\_\{t-1\})$.

4. *Action selection:*

$$u\_t = \text{argmin}\_u \, \text{KL}\left(q\left(x\_t\right) q\left(z\_t\right) \parallel p\left(x\_t, z\_t \mid u\right)\right)$$

where KL(.) denotes the Kullback–Leibler divergence between the two distributions.

5. *Updating internal states:*

$$z\_t \sim q\left(z\_t \mid y\_t, u\_t\right)$$

The above equations describe how the agent's beliefs about the environment and its own internal states are updated over time based on sensory input and actions, and how the agent selects actions to minimize surprise and update its internal states accordingly.

1.3 A predictive semiotic model

From a phenomenological, radical embodied perspective (Torres-Martínez 2018a, 2018b, 2023a, 2023b, 2023c), the processing of multimodal, bodily-acquired signals does not fully accommodate any fixed category of sign. However, the description of linguistic constructions introduced in this paper is semiotic, as it successfully integrates four main components: (1) a phenomenological stance whereby perception is defined as a prior, a given in itself; (2) a model of reality reconstruction based on decisions made through the integration of both exteroceptive, proprioceptive, and interoceptive signal processing (following an Active Inference model); (3) an agentive selection of constructions on the basis of *uncertainty-driven patterns of constructional relations* termed herein constructional attachment patterns; (4) a Peircean definition of sign[3] as

3 The triadic architecture of constructions rests on three basic sign relations described by Peirce as follows:

> There are three kinds of signs which are all indispensable in all reasoning; the first is the diagrammatic sign or icon, which exhibits a similarity or analogy to the subject of discourse; the second is the index, which like a pronoun demonstrative or relative, forces the attention to the particular object intended without describing it; the third (or symbol) is the general name or description which signifies its object by means of an association of ideas or habitual connection between the name and the character signified. (*CP* 1.369; cf. *CP* 2.247–2.249; cf. *CP* 4.447–4.448)

a semiotic continuum of icons (hypotheses, resemblances, qualities), indices (reactions, contiguity), and symbols (laws). The integration of these components provides the conceptual background for the introduction of a triadic model of constructions based on embodied agency, form, and function. The role of embodied cognition in the construction of a comprehensive semiotic theory of mind and language seeks to offer a more nuanced set of responses regarding the constitution of the Self. In this sense, it is assumed that the continuity between the mind and the physical properties of the world is a default quality of those systems that have emerged from the world that supports their existence (which denies the existence of the so-called *hard problem of consciousness*, Chalmers 1995). In other words, there is not a gap between the physical and the mental.

We can now unify the model of intelligent agency as a dynamic process based on both active inference and the Peircean theory of signs.

Table 1: Correlation between AIF and the Peircean theory of signs.

Active inference	**Peircean theory of signs**
Iconic agency	Firstness (Qualisign)
Variational free energy (F)	Dynamic object (Rheme)
Approximate posterior (q)	Immediate interpretant
True joint distribution (P)	Dynamic object (Rheme)
Sensory evidence (e)	Immediate object (pheme)
Evidence likelihood (ln $P(e)$)	Representamen (sign)
Belief updating	Interpretation
Precision (β)	Semiotic constraint
Indexical agency	Secondness (Sinsign)
Symbolic agency	Thirdness (Legisign)

We can now correlate the elements in Table 1 as follows.

1. Iconic Agency:
   - *Active Inference*: Represents the construction of iconic agency through belief updating based on sensory evidence.
   - *Peircean Theory*: Relates to Firstness or the realm of qualities and potential qualities. Iconic agency captures the essence of the *qualisign.*
2. Variational Free Energy (F):
   - *Active Inference*: Measures the discrepancy between the approximate posterior distribution and the true joint distribution.
   - *Peircean Theory*: Corresponds to the dynamic object or *rheme*, pointing to the essential character of a sign as contingent mediator. F represents the dynamic aspect of the object being modeled.

3. Approximate Posterior (q):
   - *Active Inference*: Approximates the posterior distribution over beliefs about agency construction.
   - *Peircean Theory*: Relates to the immediate interpretant, that is, the mental representation or interpretation of a sign. q captures the approximate beliefs about agency construction.
4. True Joint Distribution (P):
   - *Active Inference*: Represents the true distribution of beliefs and sensory evidence associated with agency construction.
   - *Peircean Theory*: Corresponds to the dynamic object or *rheme*, that is, the object as existing independently of any representation. P represents the true joint distribution of beliefs and sensory evidence.
5. Sensory Evidence (e):
   - *Active Inference*: Refers to the sensory inputs or evidence used to update beliefs about agency construction.
   - *Peircean Theory*: Relates to the immediate object or *pheme*, that is, the portion of the sign that is directly apprehended. e represents the sensory evidence used during belief updating.
6. Evidence Likelihood ($\ln P(e)$):
   - *Active Inference*: Captures the likelihood of the observed sensory evidence.
   - *Peircean Theory*: Corresponds to the representamen or the sign-as-vehicle itself. *P(e)* represents the interpretive likelihood associated with sensory input.
7. Belief Updating:
   - *Active Inference*: The process of adjusting beliefs to align with the observed sensory evidence.
   - *Peircean Theory*: Relates to the interpretation of signs, where the mind actively engages in the construction of meaning through signs.
8. Precision (β):
   - *Active Inference*: Represents the learning rate, or the precision of belief updating.
   - *Peircean Theory*: Corresponds to semiotic constraints, which imposes limitations on the interpretation process. β determines the rate of belief updating.
9. Indexical Agency:
   - *Active Inference*: Represents the construction of indexical agency through belief updating based on sensory evidence.
10. Peircean Theory: Relates to Secondness or the realm of brute facts and Symbolic Agency:
   - *Active Inference*: Represents the construction of symbolic agency through belief updating based on sensory evidence.

– *Peircean Theory*: Corresponds to Thirdness or the realm of general laws and concepts. Symbolic agency captures the use of signs to represent abstract and general concepts.

Based on the elements in Table 1, we can provide a unifying equation that encompasses both Active Inference and the Peircean theory of signs:

Unifying Equation:

$$\Psi = F + \eta \sum (\delta(t) + \gamma(t))$$

In this equation, Ψ represents the overall process of agency construction and deployment. The equation incorporates the variational free energy term F from Active Inference, as well as the prediction error term $\delta(t)$ and the precision parameter η.

Additionally, the equation includes two additional terms that capture the influence of the Peircean theory of signs. The term $\sum(\delta(t) + \gamma(t))$ represents the sum of the prediction error $\delta(t)$ and the dynamic interpretant $\gamma(t)$ associated with the ongoing semiotic process. The dynamic interpretant captures the process of meaning-making and the continuous interpretation of signs within the agent's cognitive system.

1.4 Constructional attachment patterns

In this context, human linguistic behavior is structured around recurrent hypothesis-driven semiotic models termed Constructional Attachment Patterns (CAPs, see Torres-Martínez 2015, 2016, 2017, 2018a, 2018b, 2019, 2021a, 2021b, 2022a, 2022b, 2022c, 2023a, 2023b, 2023c, 2023d) that work as templates for the selection of specific phrasal, sub-sentential, and sentence models of constructional associations. CAPs are not hidden semiotic diagrams, in the sense that they do not come as an *a priori* within a particular syntactic structure, but guide speaker selections based on "agentive imperatives," rather than statistical ones, thereby facilitating the emergence of categories in communication. Importantly, this type of communication type does not adhere to any polar framework, that is, that purpose extends beyond the definition of statefulness and statelessness during communication (Ludlow and Živanović 2022: 166). As a result, agents are characterized by a type of bodily awareness that I define as follows (see also Torres-Martínez accepted),

> the representation of the Self in the world through the conjunction of perceptual states, conceptualizations thereof and the ensuing projection of a set of beliefs onto specific events in a context of use.

CAPs can be defined as the sum of weighted connections between linguistic constructions (C) and embodied representations (ER). CAPs are semiotic relations among constructions that are driven by hypotheses and are shaped as predictions for the reconstruction of events (Torres-Martínez 2023a, 2023b). This reconstruction process encompasses the integration of sensory and experiential aspects, a process captured by the formula below:

$$\text{CAP} = \{w\_ij\}$$

where *w_ij* represents the weight of the connection between a construction *i* and an embodied representation *j*. These weights reflect the strength of the association between the linguistic and embodied components and can be learned through exposure and reinforcement. Finally, we can define the overall embodied representation (ER) as a linear combination of the exteroceptive and interoceptive re-enactment routines weighted by CAPs:

$$\text{ER} = \Sigma w\_ij * (\alpha * \Sigma a + \beta * \Sigma s)$$

The equation captures the idea that the embodied representation is a product of the interactions between the linguistic and embodied components that are mediated by the re-enactment routines and CAPs. A good example is *argument structure constructions* (ASCs, Torres-Martínez 2015, 2016, 2017, 2018a, 2018b), that is, abstract syntactic templates that encode not only feedforward, exteroceptive content (associated with path, direction, containment, verticality, etc.), but also combinations of afferent (sensory) information arising from interoceptive organs responsible for "the generation and regulation of cognitive and emotional behaviors" (Berntson et al. 2019: 3).

The specific weighting of the exteroceptive and interoceptive re-enactment routines by CAPs reflects the degree to which different linguistic constructions are associated with different sensorimotor experiences and how these associations are modulated by the organism's bodily awareness. We can define the exteroceptive re-enactment routines (*r*_ext) as follows:

$$r\_\text{ext} = \alpha * \Sigma a$$

where α is a parameter that represents the sensitivity of the organism to affordances, and Σa is the sum of all the affordances present in the environment. This equation captures the idea that exteroceptive signals motivate motor re-enactment by activating the affordances that are relevant for the current context. The more affordances are present, the stronger the activation of the corresponding re-enactment routines. In addition, we can define the interoceptive re-enactment routines (*r*_int) as follows:

$$r\_\text{int} = \beta * \Sigma s$$

where β is a parameter that represents the sensitivity of the organism to interoceptive signals, and Σs is the sum of all the bodily sensations and emotional states that are present. This equation captures the idea that interoceptive signals motivate interoceptive re-enactment by activating the bodily awareness that is relevant for the current context. The more intense the bodily sensations or emotions, the stronger the activation of the corresponding re-enactment routines.

As we can see, CAPs are crucial for the emergence and further entrenchment of form-function symbolic relations in the form of constructions in the *linguistic system* (LS). CAPs also express how specific mental simulations, e.g., *speed simulations* (SM), whereby specific action verbs are selected to accommodate a perceived speed rate "are not simply shallow re-enactments, but operate at a fine grain according to specific properties about real-world interactions" (Speed and Vigliocco 2014: 381).

(1) a. The car silently *slithered away* **from** the curb.
b. Fog *rippled through* the ravines.
c. He wearily **pulled** himself **into** the car.

Along the same lines, embodied content is reflected in *abstract action sentence processing* (AASP), whereby "sensorimotor processes [are] recruited during abstract action language comprehension" (Schaller et al. 2017: 1346).

(2) [Caused motion: X causes Y to move from/to Z]
a. The rear tires **chewed up** *the ground*.
b. Experience it's all those things that **build up** who you are.
c. He **turned over** his problems *to* her wife.

In addition, CAPs reflect the evolution of *spatial perspective taking* (SPT), a type of sensorimotor mental alignment. According to Kessler and Thompson (2010: 86) "SPT could mark the transition from responsive physical alignment of attention – available to primates and a few other species – to the conscious and deliberate mental transformation into another perspective of the world – *available to humans only*…"

(3) Let's see if this dress fits, she said, **holding** it **up** to me.

2 The triadicity of constructions

One important consequence of the previous discussion (see Section 1.3) is that the structure of triadic linguistic constructions (Torres-Martínez 2018a, 2018b) reveals the existence of a *bodily Self* (intelligent agent, that is, A) that is a requirement for the selection of specific CAP arrangements. CAPs are responsible for the semiotic reconstruction of experience through iconic, indexical, and symbolic links which

converge to create conventionalized form-function pairings bestowed of agentive properties (that is, triadic constructions, TC). In particular, iconic (imagistic) links provide a pre-cognitive association between concepts and referent objects in terms of form and function. During their passing from qualities (icons) to indices (signs conveying information in terms of contiguity and reaction), referent objects display relational properties. The definition of a triadic construction is this:

> Linguistic constructions are *triads of form, function and intelligent agency* that emerge through the combination of specific constructional attachment patterns, that is, embodied constructional arrangements that organize both high-level (abstract syntactic patterns) and low-level constructions such as words, morphemes, affixes, etc., in networks of interconstructional relations motivated by agentive selections.

To integrate the definition of triadic linguistic constructions and the role of CAPs in the semiotic reconstruction of experience with the existing model, additional variables are required:

First, we define the *bodily Self* or *Agent* (A) as a representation of the organism's embodied existence and subjective experience:

$$A = [a\_1, a\_2, \ldots, a\_m]$$

where m is the number of bodily self attributes, and a_i represents a specific attribute of the bodily self (e.g., physical sensations, emotions, intentions).

We can then define the specific CAP arrangements (CAP_arr) as a set of specialized patterns that are responsible for the semiotic reconstruction of experience:

$$\text{CAP\_arr} = \{cap\_k\}$$

where *cap_k* represents a specific CAP arrangement that links linguistic constructions, embodied representations, and referents in the world. Each CAP arrangement captures the associations between form, function, and agentive properties in a triadic construction (TC).

Now, we introduce three types of links: iconic (*I*), indexical (*X*), and symbolic (*S*), which connect concepts, form-function relations, and referents:

$$I = \{i\_l\} X = \{x\_l\} S = \{s\_l\}$$

where *i_l*, *x_l*, and *s_l* represent specific links of the respective type.

We can define the iconic links as pre-cognitive associations between concepts and referent objects in terms of form and function:

$$i\_l = \{concept\_i, referent\_object\_i\}$$

where *concept_i* represents a specific concept and *referent_object_i* represents a specific referent object that are associated iconically.

The indexical links represent signs conveying information through contiguity and reaction, displaying relational properties:

$$x\_l = \{form\_function\_relation\_l, referent\_properties\_l\}$$

where *form_function_relation_l* represents a specific form-function relation and *referent_properties_l* represents specific relational properties of the referent object associated with the form-function relation.

The symbolic links connect concepts, form-function relations, and referents in the world:

$$s\_l = \{concept\_i, form\_function\_relation\_l, referent\_object\_i\}$$

where *concept_i*, *form_function_relation_l*, and *referent_object_i* represent the elements connected symbolically.

To capture the integration of these components, we can modify the equation for the *embodied representation* (ER) as follows:

$$\mathrm{ER} = \Sigma w\_ij^{*}(\alpha^{*}\Sigma a + \beta^{*}\Sigma s + \gamma^{*}\Sigma i\_l + \delta^{*}\Sigma x\_l + \lambda^{*}\Sigma s\_l)$$

where γ, δ, and λ are parameters that represent the importance or influence of the iconic, indexical, and symbolic links, respectively, on the formation of the embodied representation. The weighted sums of iconic, indexical, and symbolic links are added to the existing equation, reflecting their contribution to the overall embodied representation.

Finally, we can extend the equation for *free energy* (F) to incorporate the role of triadic linguistic constructions and CAP arrangements:

$$\begin{aligned}\boldsymbol{F} = {} & \mathrm{PE} + \Sigma\theta\_i^{*}(\ln \pi\_i + \ln \theta\_i) + \Sigma w\_ij \\ & {}^{*}(\alpha^{*}\Sigma a + \beta^{*}\Sigma s + \gamma^{*}\Sigma i\_l + \delta^{*}\Sigma x\_l + \lambda^{*}\Sigma s\_l) + \Sigma w\_k^{*}\mathrm{TC}\_k.\end{aligned}$$

where TC_*k* represents a specific triadic construction, and Σw_k reflects the influence of CAP arrangements on the free energy. This equation captures the idea that the formation of embodied representations and the selection of action policies are influenced by the triadic linguistic constructions and CAP arrangements, which introduce additional constraints and regularities in the semiotic reconstruction of experience.

2.1 Argument structure constructions encode intelligent agency

As previously noted, perception and cognition mutually influence each other, with habitual perceptual routines often taking precedence and creating a context for predictive action. Thus.

Table 2: A summary of argument structure constructions integrating the intelligent agency component.

Argument structure construction	Form	Meaning	Intelligent agency	Equation
Caused motion	(Subj) VObjObliquePATH	X causes Y to move from/to Z	IA_caused_motion	*F*_caused_motion = IA_caused_motion + (Σ*w_k*_cm/TC_cm)
Intransitive motion	(Subj) VObliquePATH	X moves to Z	IA_intransitive_motion	*F*_intransitive_motion = IA_intransitive_motion + (Σ*w_k*_im/TC_im)
Transitive	(Subj)VObj	X acts on Y	IA_transitive	*F*_transitive = IA_transitive + (Σ*w_k*_t/TC_t)
Caused-motion (prepositional dative)	(Subj)VObj1Obj2	X causes Y to receive Z	IA_caused_motion_pd	*F*_caused_motion_pd = IA_caused_motion_pd + (Σ*w_k*_cm_pd/TC_cm_pd)

- Intelligent agents utilize language as a predictive tool for adaptive actions in the world.
- Embodied experience is direct and ecological, meaning that representational layers are not added to events in the brain.
- Embodied cognition reflects the necessity to reconstruct events based on bodily-acquired information.

In particular, syntactic abstract constructions (argument structure constructions) encode specific cognitive tendencies in the form of an innate knowledge of world physics and affordance mapping.[4] For the purposes of this discussion, four ASCs are of interest for our analysis. As illustrated in Table 2, ASCs encompass several components and relations.

The components, equations, and relations within the model are:

Components.

- Argument structure construction: Describes the syntactic structure and form of a specific construction.
- Form: The linguistic expression or pattern that represents the argument structure construction.

4 An affordance (Gibson 1966, 1977) is a potentiality that can be used by an agent in a given way according to its phylogenetic configuration. Objects can thus be used in manners defined by criteria such as weight, size, form, etc., that are perceptually accessible, which results in the emergence of specific action profiles.

- Meaning: The semantic interpretation or function associated with the construction.
- Intelligent agency: Represents the influence or involvement of an intelligent agent in the construction.
- Equation: The equation that incorporates the intelligent agency factor and the associated triadic construction into the calculation of free energy.

Equations.
- *F*_caused_motion: Free energy equation for the Caused Motion construction.
- *F*_intransitive_motion: Free energy equation for the Intransitive Motion construction.
- *F*_transitive: Free energy equation for the Transitive construction.
- *F*_caused_motion_pd: Free energy equation for the Caused-motion (prepositional dative) construction.

Relations.
- IA_caused_motion, IA_intransitive_motion, IA_transitive, IA_caused_motion_pd: These variables represent the intelligent agency factors associated with each construction, capturing the influence of intelligent agents on the embodied representation.
- (Σ*w_k*_cm/TC_cm) (Σ*w_k*_im/TC_im), (Σ*w_k_t*/TC_*t*) (Σ*w_k*_cm_pd/TC_cm_pd): These terms denote the weights (*w_k*) associated with the triadic constructions (TC) and their respective argument structure constructions, quantifying the importance or relevance of each triadic construction.
- The equations for free energy (*F*) combine the prediction error (PE) with the contributions of intelligent agency and the associated triadic constructions, providing a measure of the overall information processing and embodiment within the model.

2.2 Argument structure and free energy

Thus far, we have seen how linguistic constructions reflect embodied re-enactment routines as a strategy to reduce uncertainty. Abstract syntactic constructions are only a subset of multisemiotic units of sense used to reduce uncertainty affected by intelligent agency factors.

These complex relationships are captured by the formula of free energy as follows:

$$F = \mathrm{PE} + \Sigma\theta\_i * (\ln \pi\_i + \ln \theta\_i) + \Sigma w\_ij * (\alpha * \Sigma a + \beta * \Sigma s + \gamma * \Sigma i\_l + \delta * \Sigma x\_l + \lambda * \Sigma s\_l)$$
$$+ F\_\text{caused\_motion} + F\_\text{intransitive\_motion} + F\_\text{transitive}$$
$$+ F\_\text{caused\_motion\_pd}$$

Where intelligent argentic states are encoded by the following argument structure constructions:

$$F\_\text{caused\_motion} = \text{IA\_caused\_motion} + (\Sigma w\_k\_\text{cm} / \text{TC\_cm})$$

$$F\_\text{intransitive\_motion} = \text{IA\_intransitive\_motion} + (\Sigma w\_k\_\text{im} / \text{TC\_im})$$

$$F\_\text{transitive} = \text{IA\_transitive} + (\Sigma w\_k\_t / \text{TC\_}t)$$

$$F\_\text{caused\_motion\_pd} = \text{IA\_caused\_motion\_pd} + (\Sigma w\_k\_\text{cm\_pd} / \text{TC\_cm\_pd})$$

Incorporating these equations into the model allows us to account for the influence of intelligent agency and the associated triadic constructions on the free energy estimation. The variables IA_caused_motion, IA_intransitive_motion, IA_transitive, and IA_caused_motion_pd represent the respective intelligent agency factors for each construction, while TC_cm, TC_im, TC_*t*, and TC_cm_pd represent the associated triadic constructions. The weights *w_k*_cm, *w_k*_im, *w_k_t*, and *w_k*_cm_pd reflect the relevance or influence of the corresponding triadic constructions on the prediction processes.

Now, let's analyze a specific type of constructions, phrasal verbs, using the previous theory. If we combine the three components of the construction, form, function and intelligent agency, we can determine the embodied structure of phrasal verbs, thus.

(4) Triadic construction

	Some consultants	***farmed out***	work	to contractors.
Form	Subject	Verb	Obj.1	Obj. 2
Function (ASC)	*X*	Transfers	*Y*	to Z
Intelligent agency	*F*_caused_motion_pd = IA_caused_motion_pd + (Σ*w_k*_cm_pd / TC_ *t*_farm_out)			

The above schema illustrates the traditional construction grammar formalisms for the analysis of constructions plus the addition of the intelligent agency component. These components can be further analyzed as follows:

1. Triadic Construction: The given sentence "Some consultants farmed out work to contractors" represents a triadic construction involving the subject "Some consultants," the verb "farmed out," and the objects "work" and "contractors." The form of the construction can be represented as: Form: Subject (Some consultants) + Verb (farmed out) + Object 1 (work) + Object 2 (contractors)

2. Function: The function of the argument structure construction (ASC) in this case is to transfer or delegate the work (Object 1) from the consultants (Subject) to the contractors (Object 2). It captures the meaning and relationship between the elements involved in the construction. Function (ASC): *X* (Some consultants) transfers *Y* (work) to *Z* (contractors)
3. Intelligent Agency: To determine the intelligent agency factor, we can use the equation for the Caused-motion (prepositional dative) construction:

$$F\_\text{caused\_motion\_pd} = \text{IA\_caused\_motion\_pd} + (\Sigma w\_k\_\text{cm\_pd}/\text{TC\_cm\_pd})$$

In this case, the intelligent agency factor for the "farmed out" construction can be denoted as IA_caused_motion_pd. It represents the influence of intelligent agency on the phrasal verb and its associated meaning.

To summarize, the embodied structure of the phrasal verb "farmed out" can be represented as follows: Triadic Construction: Subject (Some consultants) + Verb (farmed out) + Object 1 (work) + Object 2 (contractors) Function (ASC): X (Some consultants) transfers *Y* (work) to *Z* (contractors) Intelligent Agency: *F*_caused_motion_pd = IA_caused_motion_pd + (Σ*w*_*k*_cm_pd/TC_cm_pd)

As we can see, the analysis of specific constructions within this theory provides a glimpse into its embodied structure, including its form, function, and the influence of intelligent agency on the construction.

3 Intelligent agency in Spanish, Mayan, Icelandic, and Faroese

As previously highlighted, the primary distinction in the current definition of mind and cognitive agents lies in the absence of an assumption regarding a unified, rational, and intelligent behavior serving as a measure for representation (e.g., Pietroski 2018). Additionally, the agentive nature of subjective experience is emphasized. It is necessary to note that human decisions about the state of the world may not align with rationality or adhere to a mathematical ideal of logical reasoning, as envisioned by computer science and neuroscience. Therefore, the process of conceptualization does not involve a mere selection of objects within the brain, but rather entails the intricate integration of the *Self* reconnecting with the phenomenal substance of objects, entities, and events.

From this perspective, an organism is conceptualized as a system engaged in a continual loop of energy exchange with itself and the world. It is important to clarify that, unlike the free-energy principle, perceptual loops in this framework are not directed towards reducing entropy. The bodily Self is a product of intention, serving

as the driving force of action and a key factor for survival. The crucial point is that a sense of agency emerges from the intentional application of past experiences to novel situations. For instance, the concept of event partition is best explained in terms of the hybridization of agentic models of action activated to navigate uncertainty.

A significant implication of adopting this model is that, unlike the *Free Energy Principle* (FEP) and the Active Inference framework (FEP-AI) proposed by Friston (2010) and Friston et al. (2017), the current characterization assumes that the systems responsible for reconstructing experience are not inherently hierarchical. This is because surprise does not necessarily lead to system entropy, since an interpretation of the system's state is not given by a single parameter of the system at some point of the interpretive process (semiosis). Consequently, the suggestion is that living organisms, in order to ensure survival, must actively modify the environment to align with their needs in terms of an integration of particular states of being in the world. This claim also points to an important theoretical tenet of AgCCxG; that language is representational, as it can be used to actually represent, through specific meanings, a state of affairs in the world. In other words, "the meaning of a linguistic expression is not a fundamental property of it – that a linguistic expression has the meaning it has by virtue of something else being the case about it" (Zalabardo 2023: 1). It is from this perspective that language can actually mean something without there being a need for us to ask, "What do we mean by this or that sentence?" The need to obtain some other facts as a condition to make propositions meaningful squares well with a view of language by which propositions do not exist in isolation but are to a large extent sufficiently licensed by a battery of facts associated with it. So, sentences are deemed to encode, too, the occurrences in the world in which an agent can participate. This is where I now turn.

3.1 Epistemic delay

One compelling example illustrating that meaning in language is not solely tied to expressions themselves but also to the structure of the events in which they are uttered is found in mirative constructions. Mirative constructions convey a form of informed inference wherein the speaker possesses partial access to the structure of a past state of affairs.

(5) ¡No lo habrás perdonado . . . ! (The expectation is that the addressee did not do it)
'Don't (you) him Will-Have-[mirative] forgiven!'
['You didn't forgive him, did you?']

As we can see in (5), the access to the content is granted by both world knowledge and specific information regarding an agent's previous behavior (represented in English by the tag question). The inference is made on the basis of a negative evaluation of a possible past behavior, which, in Spanish, is framed in terms of a pseudo modal construction, accompanied by a typical intonation and distinct facial signals expressing a blend of multiple emotions (anger, surprise, disappointment, or shame).

It should be noted, however, that the present use of the term includes an agentive component not present in the original definition: "Mirativity is widely expressed by lexicalized adverbials, conventionalized constructions (English (It) turns out (that) S), intonation, sentence final "evaluative" particles and other devices which are often not considered part of the grammatical structure of a language" (DeLancey 2012: 533).

Therefore, in the current analysis, the conceptualizer questions a past action by AGENT 2, in other words, AGENT 1 infers that a decision made by AGENT 2 has led to undesirable consequences (the person appraised is held responsible for the problem). A specific intonation stresses the disapproval of the action, an agentive dissonance that reveals the accountability-oriented nature of the agency brought up by the agent conceptualizer. In this sense, the attachment pattern entails a past decision that is brought to the present by the future tense suffix "-as" (an indexical), marking a neutral mental space created to avoid asserting a present condition (since no real evidence exists). It is expected that the addressee reacts by providing clarification or justification (as is the case with appraisals associated with guilt or shame), since to be found lacking can be disastrous for the agentive status of the individual in the community. The concept of epistemic delay refers to a phenomenon where the speaker has partial access to the structure of a past state of affairs and makes an informed inference based on that limited access. In the given example (2), the mirative construction expresses this kind of inference. The speaker questions whether the addressee has forgiven someone based on negative evaluation of a possible past behavior. This inference is made using world knowledge and specific information about the agent's previous behavior.

The mirative construction in Spanish is accompanied by a pseudo-modal construction and distinct intonation and facial signals that convey a mix of emotions, such as anger, surprise, disappointment, or shame. The use of such expressions implies an agentive component, wherein the speaker questions the past action of another agent and holds them responsible for the undesirable consequences of that action. The attachment pattern in this construction involves a past decision brought to the present through the future tense suffix "-as." This neutral mental space allows the speaker to refrain from asserting a present condition without concrete evidence. The speaker thus anticipates the addressee to react by providing clarification or justification, as being found lacking in this context can have negative implications for the agent's status in the community.

A more comprehensive analysis of epistemic delay in (5) is possible when we consider the dynamics of probabilities P and C as described by the differential equations:

$$dP/dt = -k1P + k2C$$

$$dC/dt = -k3C + k4P$$

These equations represent the rates of change of *P* and *C* over time. Let's interpret *P* as the probability that the speaker's belief-driven model aligns with the addressee's previous experience, and *C* as the probability that the addressee's conceptualization aligns with the speaker's belief-driven model. The values of *k*1, *k*2, *k*3, and *k*4 determine the specific behavior of the system.

In the context of epistemic delay, we can apply these equations to analyze how *P* and *C* change over time, reflecting the interplay between the speaker's inference and the addressee's conceptual alignment. For example, when the speaker uses the mirative construction, they are making an inference about the addressee's past behavior. Let's denote the variables as follows:

P(*t*) = Probability that the speaker's belief-driven model aligns with the addressee's previous experience at time *t*.
C(*t*) = Probability that the addressee's conceptualization aligns with the speaker's belief-driven model at time *t*.

We can solve these equations to determine how *P* and *C* evolve over time. The specific values of *k*1, *k*2, *k*3, and *k*4 would depend on contextual and cognitive factors, but for the purpose of illustration, let's consider a scenario where $k1 = k2 = k3 = k4 = 1$.

By substituting these values into the equations, we get:

$$dP/dt = -P + C$$

$$dC/dt = -C + P$$

Let's solve these equations:

$$dP/dt = -P + C$$

Separate the variables:

$$dP/P = (C - P)\,dt$$

Integrate both sides:

$$\int dP/P = \int (C - P)\,dt$$

$$\ln|P| = Ct - (1/2)t\text{^}2 + \text{constant1}$$

Exponentiating both sides:

$$P = e\text{^}(Ct - (1/2)t\text{^}2 + \text{constant1}) \quad (1)$$

Similarly, let's solve the second equation:

$$dC/dt = -C + P$$

Separate the variables:

$$dC/C = (P - C)dt$$

Integrate both sides:

$$\int dC/C = \int (P - C)dt$$

$$\ln|C| = Pt - (1/2)t\text{^}2 + \text{constant2}$$

Exponentiating both sides:

$$C = e\text{^}(Pt - (1/2)t\text{^}2 + \text{constant2}) \quad (2)$$

Equations (1) and (2) provide the general solutions for *P* and *C*, respectively, in terms of the given differential equations. The integration constants have been absorbed into the exponential terms. These solutions demonstrate the evolving probabilities of belief alignment and conceptual alignment between the speaker and addressee over time. The specific values of *k*1, *k*2, *k*3, and *k*4, which depend on contextual and cognitive factors, would determine the precise behavior and dynamics of *P* and *C*.

3.2 Epistemic blocking

The primary function of *epistemic blocking* is to reduce the impact of an otherwise "on the nose" epistemic evaluation, aiming to maintain an emotional connection with the interlocutor. This differs from hedging in that the latter seeks to safeguard the speaker's entitlement from unequivocally asserting the true value of a state of affairs without any evidence. To illustrate, compare the following utterances used as an answer to the utterance "Me siento mal del estómago" ('I feel sick to my stomach').

(6) a) Modal construction
"Debe haber sido el pescado"
['It must have been the fish']

b) Mirative construction
"Habrá sido el pescado"
(It) Will-Have-[mirative] been the fish
['It was (probably) the fish']

In 6a, a typical modal construction that associates the meaning of the modal *deber* ('must') and the (implicit) full verb *comer* ('eat'), the agent conceptualizer provides a possible scenario in which the present state of affairs is conceptualized as the result of a previous action. This construction is flexibility oriented, that is, the conceptualizer displays full control and composition on the basis of world knowledge (epistemic entitlement).

In contrast, in 6b, the conceptualizer attempts to empathize with the interlocutor's situation by creating an *I-do-care* mental space in the form of a pseudo future construction and a specific intonation. The intention is thus to show that you really care for the person in trouble instead of simply committing to the truthfulness of the event by providing an epistemic judgment on the matter.

These constructions call for a disambiguation of the relations between agents, their roles in the event, and the means by which speaker stance and linguistic content combine to constitute meaning. In these constructions, it becomes evident that desire is not private but is contingent on the rules of agency distribution available to agent conceptualizers within a given culture. Clearly, the type of agency involved indicates that the agent conceptualizer, although lacking full control to actualize an implicit request for help, exhibits a level of epistemic evidentiality that enables them to anticipate a positive reaction from the interlocutor (implying that they are indeed willing to help). Simultaneously, this creates an epistemic dislocation that renders a potential evaluation of the truth value of the event unnecessary.

In the context of epistemic blocking, we can analyze the dynamics using similar equations as before. Let's denote the variables as follows.

$P(t)$ = Probability that the speaker's belief-driven model aligns with the addressee's previous experience at time t.

$C(t)$ = Probability that the addressee's conceptualization aligns with the speaker's belief-driven model at time t.

Again, we can use the following differential equations to describe the dynamics:

$$dP/dt = -k1P + k2C$$

$$dC/dt = -k3C + k4P$$

In this case, we are considering the mirative construction as an example of epistemic blocking. The speaker is attempting to empathize with the interlocutor's situation and preserve an emotional connection. Let's assume $k1 = k2 = k3 = k4 = 1$ for simplicity.

By substituting these values into the equations, we get:

$$dP/dt = -P + C$$

$$dC/dt = -C + P$$

Solving these equations:

$$dP/dt = -P + C$$

Separate the variables:

$$dP/P = (C - P)\,dt$$

Integrate both sides:

$$\int dP/P = \int (C - P)\,dt$$

$$\ln|P| = Ct - (1/2)t\text{^}2 + \text{constant1}$$

Exponentiating both sides:

$$P = e\text{^}(Ct - (1/2)t\text{^}2 + \text{constant1}) \tag{3}$$

Similarly, for the second equation:

$$dC/dt = -C + P$$

Separate the variables:

$$\mathrm{d}C/C = (P - C)\,dt$$

Integrate both sides:

$$\int dC/C = \int (P - C)dt$$

$$\ln|C| = Pt - (1/2)t\text{^}2 + \text{constant2}$$

Exponentiating both sides:

$$C = e\text{^}(Pt - (1/2)t\text{^}2 + \text{constant2}) \tag{4}$$

Equations (3) and (4) provide the general solutions for P and C, respectively, in terms of the given differential equations. In the context of epistemic blocking, these solutions describe how P and C evolve over time, reflecting the interplay between the speaker's inference and the addressee's conceptual alignment. The mirative construction in this case aims to create a mental space that shows empathy and care for the interlocutor, while avoiding a direct epistemic judgment on the matter. This emotional connection is prioritized over providing a definitive evaluation of the truth value of the event.

3.3 Epistemic displacement: the case of *raj* ('would')

Another case of epistemic dislocation occurs when an agent conceptualizer refrains from committing to the truth value of an event (implying epistemic entitlement) by

placing the onus of conceptualization on the anticipation of a reaction of a potential agent addressee carrying the weight of the actualization of the action. In order to illustrate this, I will use an example provided by Kockelman (2010: 1–2). The author reports the case of a Mayan boy, Maynor, who nearly hits the anthropologist's outstretched foot with a tiny chair. The misbehavior of the child is observed by his ten-year-old cousin who calls the boy's mother's attention by saying "xten *raj* li roq' laj Maynor" ('Maynor *would* have hit his foot' [Kockelman's translation; my emphasis]). According to Kockelman, the use of the counterfactual *raj* "signals that she is committed to the truth of the narrated event in a world other than that of the speech event. In effect, she says, 'In another world (but not in this one), Maynor hit the anthropologist's foot'" (Kockelman 2010: 2).

We see that Kockelman splits the agentivity of the little girl into "the role of animator (articulating an utterance in this world – the speech event); and the role of principal (committed to the truth of the proposition expressed by her utterance in another world – the commitment event)."

However, as suggested above, the agent-conceptualizer and the agent narrator are the same in terms of intentionality. Therefore, speech events, that is, "an actual situation of speaking" (Enfield 2013: 126) are not separated from narrated events, i.e., "state[s] of affairs being talked about" (Enfield 2013: 126), since the conceptualizer's commitment to the truth value of the narrated event is part of a single agentive event. The reason is that language serves to distribute agentive roles beyond reference. This reduces the incongruence between what you can see, what you can do, what you can infer, what you can assess (involving control and composition), and the reactions of others to our appraisal of the causes that have led to a given state of affairs (representation).

Therefore, the little girl makes use of the indexical marker *raj* to call the attention of the boy's mother (primary force) thereby prompting an intervention that prevents the kid from harming others and himself. The epistemic delay is thus realized through the creation of a mental space in which the kid's cousin foresees the reaction of the kid's mother by pointing to a behavior that could be assessed as potentially harmful.

Embodied agency allows the girl to align intentional states such as desire (aiming at altering the world) and beliefs (a set of priors aiming at the truth) without having to dissociate her agentive role vis-à-vis the speech act and the narrated event. It also provides the cognitive underpinnings for the separation of the Self from the environment thereby creating the conditions for the structuring of specific actions. Crucially, the phenomenon of epistemic delay brings to the fore the need to strike a balance between individuation and an established network of social relations through the anticipation of and further alignment with others' attitudes and beliefs. It should be noted that overlapping agency activations between the Self and others

during events of agency distribution (entailing collective emotions) are not determined solely by processes of indexicality (e.g., Kockelman 2017) whereby specific statuses are anticipated on "assumptions as to how members of such statuses behave (e.g., busboys will act in the following ways)" (Kockelman 2012: 95).

In order to analyze the dynamics of epistemic displacement and its connection with intelligent agency, we can incorporate the concept of *epistemic delay* and the use of the indexical marker *raj* into our previous framework.

Considering the situation described, where the little girl uses the phrase 'Maynor would have hit his foot' (*raj li roq' laj Maynor*) to call the attention of the boy's mother and prevent harm, we can introduce the concept of epistemic delay as a mental space created by the cousin. This mental space allows the cousin to anticipate the reaction of the boy's mother and prompt an intervention.

Let's redefine the equations (1) and (2) as follows:

Equation (1):

$$P(t) = e\text{^}(Ct - (1/2)t\text{^}2 + \ln(P0) + \text{raj\_constant})$$

Equation (2):

$$C(t) = e\text{^}(Pt - (1/2)t\text{^}2 + \ln(C0))$$

In equation (1), we add an additional term raj_constant to capture the effect of the indexical marker "raj" in the cousin's utterance. This term represents the influence of epistemic displacement and the agent-conceptualizer's refraining from committing to the truth value of the event. The cousin's intentionality is focused on the anticipation of a reaction (prediction) from the boy's mother, who carries the weight of actualizing the action.

The raj_constant introduces a delay in the growth or decay of $P(t)$ by influencing the agent-conceptualizer's belief-driven model and aligning it with the anticipated reaction of the boy's mother. This delay reflects the cognitive processes involved in epistemic displacement and the creation of a mental space to navigate social relations and potential outcomes.

Equation (2) remains the same, representing the growth or decay of $C(t)$ based on the interaction between the speaker's belief-driven model and the addressee's conceptual alignment.

The incorporation of the notion of intelligent agency emphasizes the embodied cognitive processes involved in aligning intentional states, such as desire and beliefs, without dissociating the agent's role in the speech act and the narrated event. The agent's embodied agency allows for the integration of self and environment, the structuring of specific actions, and the alignment with others' attitudes and beliefs.

By integrating these elements into our framework, we can analyze how epistemic displacement, epistemic delay, and intelligent agency interact to shape the

agent's conceptualization, belief alignment, and the anticipation of others' reactions in a social context.

In the case of the *raj* example, we can apply the integrated framework of Active Inference and intelligent agency to understand how epistemic displacement and epistemic delay influence the agent's belief formation, belief updating, and action selection processes.

3.3.1 Belief formation

The agent-conceptualizer, in this case, the little girl, forms beliefs about the event based on her prior knowledge and the sensory evidence of the boy's behavior. She refrains from committing to the truth value of the event by using the counterfactual marker "raj," indicating that in another world, Maynor would have hit the anthropologist's foot. Her belief formation incorporates the notion of epistemic displacement, where commitment to the truth value is withheld, and the emphasis is placed on the anticipation of a reaction from the boy's mother.

3.3.2 Belief updating

The little girl's beliefs are updated through active inference, thereby integrating her prior beliefs with the sensory evidence and social context. The use of *raj* introduces a delay in the adjustment of beliefs, as it signifies an alternative world where the event would have occurred. This delay in belief updating allows for the creation of a mental space where the girl anticipates the reaction of the boy's mother. Her beliefs about the potential harm caused by Maynor's behavior are modulated by this anticipation.

3.3.3 Action selection

Based on her updated beliefs, the little girl selects actions that minimize free energy or surprise. Her goal is to protect others and prevent harm. The anticipation of the boy's mother's intervention, prompted by the use of *raj*, guides the girl's action selection process. She calls the attention of the boy's mother, utilizing the indexical marker to emphasize the potential harm that could have occurred. Belief updating incorporates epistemic delay, creating a mental space where she aligns her beliefs with the anticipated reaction of the boy's mother.

Let's incorporate the equations of active inference to represent the belief formation, belief updating, and action selection processes in the context of the *raj* example.

3.3.4 Belief formation

In active inference, beliefs are represented by a probability distribution over states of the world. Let's denote the agent's beliefs as $P(s)$, where s represents the state of the world. The prior beliefs, incorporating prior knowledge and contextual information, can be denoted as $P(s|\text{prior})$. The epistemic displacement introduced by *raj* can be modeled as a conditional distribution $P(s|\text{raj})$, indicating the agent's belief in an alternative world.

3.3.5 Belief updating

Belief updating in active inference involves minimizing surprise or free energy. The agent's updated beliefs, denoted as $P(s|e)$, incorporate sensory evidence *e*. The delay in belief updating due to epistemic displacement and anticipation can be represented by introducing a time component, denoted as *t*. The agent's beliefs are updated over time based on the sensory evidence and the anticipation of the boy's mother's reaction, leading to the updated belief distribution $P(s|e,t)$.

Mathematically, belief updating can be expressed using Bayesian inference:

$$P(s|e,t) = P(s|\text{prior}) \times P(e|s) \times P(t|s) \,/\, P(e|\text{prior},t)$$

where:

$P(s|\text{prior})$ represents the prior beliefs about the state of the world.

$P(e|s)$ represents the likelihood of observing sensory evidence e given the state of the world.

$P(t|s)$ represents the anticipation of the boy's mother's reaction given the state of the world.

$P(e|\text{prior},t)$ represents the probability of observing the sensory evidence e given the prior beliefs and time.

3.3.6 Action selection

Action selection in active inference involves minimizing expected free energy or surprise by selecting actions that are expected to minimize prediction error. Let's denote the agent's actions as *a*. The agent's goal is to minimize the expected free energy $E[-\log P(e,s,a)]$, where *e* represents the sensory evidence. The action selection process can be modeled as maximizing the expected value of the agent's beliefs given the action, represented as:

$$argmax\_a\, E[P(s|e,a)]$$

where.
$P(s|e,a)$ represents the updated beliefs after taking action a and observing sensory evidence *e*.

By incorporating these equations into the context of the *raj* example, we can quantitatively represent the belief formation, belief updating, and action selection processes within the framework of active inference. These equations allow us to formally analyze the impact of epistemic displacement and epistemic delay on the agent's beliefs and decision-making.

4 Iconicity, indexicality, and symbolicity in the construction of agency in both Icelandic and Faroese

Icelandic and Faroese are two related languages spoken by about 500,000 people in Iceland and the Faroes, respectively. Both languages descend from a West variant of Old Norse spoken in Norway in the early Middle Ages and carried by Viking settlers to Iceland and the many islands scattered in the Northern sea. Although modern Icelandic and Faroese reveal a common past, their diverging evolution has resulted in the preservation of many features of the old idiom in Icelandic and the emergence of a number of innovations in Faroese (see Jónsson and Eythórsson 2005). The isolation of Icelandic has contributed to preserve many features of Old Norse, whereas the influence of Danish and other languages has influenced the grammar and phonological system of Faroese. One common feature of both languages is, however, the influence of intra-speaker variation in the construction of the linguistic system. As a result, speaker-meaning has a considerable impact in the construction of the language through the selection of specific CAPs by users, which ultimately affects the system. In the remaining of this paper, I analyze CAPs that reflect the role of intelligent agentive cognitive selections in the construction of the linguistic system. One of the CAPs reviewed is *dative alternation*, that is, the selection of dative subjects at the expense of the standard accusative, and nominative alternation, or the use of nominative case instead of accusative. The combination of specific lower-level (such as case) and high-level CAPs (e.g., argument structure constructions) in these languages reflects the primacy of agency in the construction of reality by humans. For example, the sentence *Honum snérist hugur* ('He changed his mind') in Icelandic is best explained as a partially-filled template (originally constructed in Firstness and motivated by the prototypical Subject-Verb-Object construction in Icelandic) which is further specified by a series of agentive selections. In this sense, both the argument roles, that is, caused motion (*snúa*, that is 'to turn'), experiencer (*honum*), and theme

(what has changed, i.e., *hugur*), as well as the verb's participant roles, i.e., semantically-specific argument structures expressed by case marking, are selected on the basis of an external factor (or Force 1) having an effect upon an agent conceptualizer (resulting in a world-to-agent event). Therefore, the external force is considered as the locus of intentionality in Secondness, while the resultant decision of the conceptualizer is construed as the agentive event whereby a state of affairs is actualized in Thirdness. This definition contends a widespread assumption that, in Icelandic, case variation, in particular, dative substitution in topicalized objects, is determined by the semantics of the verb only (e.g., Barðdal 2011; Jónsson and Eythórsson 2005). According to Barðdal (2011: 61), the alternation of accusative subjects "The term Dative Substitution refers to a change in the case marking of oblique or non-nominative subjects in Icelandic, more precisely the fact that accusative subjects change into dative subjects." As shown in the examples below (taken from Barðdal 2015: 391), the selection of dative object (*mér*) is being increasingly associated with a personal agent-to-world experience not conveyed by the rather world-to-agent accusative object (*mig*).

(7) ['I always want to go to Subway']
b Mér langar alltaf á Subway
['I always want to go to Subway']

This distinction is important, since *mér* becomes associated with a predicate as a means to stress iconicity (feelings), while *mig* has an indexical (reactive) function. This is also true for the accusative/dative use of object pronouns reported by Barðdal (2015: 392).

(8) a. Agnes keyrði mig út á völl.
['Agnes drove me to the airport']
b. Mamma keyrði mér heim.
['Mama drove me home']

The above examples reveal that Icelandic exhibits three levels of agency distribution that link perceptual prototypes (that is signal-processing patterns associated with specific priors and activated through bodily experience) with concepts, and, ultimately, the linguistic system. The first level is iconic agency, an instance where the agent conceptualizer exists as a potentiality, an entity that is independent from any agentive locus. As shown in example 7a, the caused-motion argument structure construction works as a diagram to arguments. In this context, the object *mig* is embedded in an action conceived of by the agent conceptualizer as the result of someone's decision to take her to the airport. The second level is termed indexical agency (where the agent-conceptualizer creates specific events related to a communicative situation). This is exemplified by 8b, where the agent conceptualizer

utilizes the icon *mér* in an indexical context whereby the specific mother-daughter relation is stressed (*mér* points to an iconic selection, thereby becoming an index to itself). Finally, the third level, symbolic agency, provides the agent conceptualizer with a repertoire of conventional signs allowing the reconstruction and further sharing of an experience whereby the agent is seen as a mediator possessing specific affordances, whereby different types of signs hybridize and evolve to help us represent entities and phenomena in terms of other entities and phenomena. Therefore, iconic reasoning is not only based on similarity, nor is it isolated from both indexical and symbolic reasoning. In other words, iconic reasoning needs to relate embodied experience with specific relations during events which ultimately become entrenched in a community of speakers as symbols.

Variation of subject case marking thus demonstrates that grammar is a fluid system that can be adapted to suit the needs of speakers. Clearly, the linguistic reconstruction of bodily experience rests on the interplay of high-order syntactic constructions providing a semiotic frame to conceptualization and low-level patterns expressing specific semantic nuances associated with the reconstruction of an event by agent conceptualizers. Going back to the first example in this Subsection, we can see that there is an alignment between the three semiotic layers in terms of the nature of the participants defining the directionality of agency in the event and ultimately the reduction of free-energy. Thus, the experiencer (*Hann*, 'he'), the undergoer (*hugur*, 'mind'), and the systemic process *snúa* (defined by environmental conditions not controlled by the agent conceptualizer, that is, a change of state) in the iconic agency stage, acquire distributional properties in which the balance between forces is interpreted by means of specific information structure. As a result, the experiencer becomes the target of an environmental causality whereby the undergoer is perceived as a living entity possessing specific affordances that are activated in response to environmental conditions.

In this context, the experiencer acts as a witness to a change of mind animated by external constraints (some posterior information provides compelling data to operate a change on a set of priors). This is reflected at the level of grammatical agency through the interplay of CAPs (entailing the interplay between quality, reaction and mediation), including the association of the dative masculine *honum* (experiencer marker) and the nominative plural *hugur* (animate undergoer). Importantly, however, the function of the undergoer in the grammatical agency layer is best understood as that of an agent fleeing from the topicalized experiencer (thereby expressing intransitive motion), and not as a typical undergoer in a transitive clause. This is why inflection (a lower-level attachment pattern) requires a larger semantic frame, namely, the syntactic construction to express complex agentive relations in the symbolic agentive layer.

This is evident in bilingual communication. A case in point is Faro-Danish, a form of Danish spoken in the Faroe Islands which displays a number of semiotic

hybridations (Petersen 2011). As with both Danish and Faroese, Faro-Danish typically draws on the iconic representation of specific phenomena that are further associated with a referential agentive semiotic system whereby low-level CAPs (such as inflection or lack thereof, verb compounding, or adverb+verb/verb+adverb placement, etc.) are selected to accomplish a communicative goal within a community of speakers. However, high-level CAPs, such as the argument structure construction selection for events, remain stable given their role as connectors of non-linguistic and linguistic content. In other words, the selection of constructions is not defined by a competition between linguistic systems, but the assignation of specific semiotic properties (iconicity, indexicality, or symbolicity) within an utterance (contra Nyholm et al. 2020; Petersen 2011).

In this sense, it is inaccurate to assert that specific constructions are erroneously chosen based on a selection in system A that mismatches a potentially more correct target selection in system B. The reason is that the linguistic system is, above all, a system that derives its consistency from the meaningful and purposeful combination of signs by speakers. From this perspective, different linguistic systems should not be considered as either recipients or target systems but as semiotic systems selected by convenience through agentive choices. In the case of Faro-Danish, Petersen (2011: 6) incorrectly assumes that agents simply select linguistic material having two systems as a reference for their choices, thus overlooking the cognitive component of any semiotic hybridizations across sign systems.

By agent speaker I mean that the same Faroese agent speaker may perform a pull-chain when speaking Faroese and borrow linguistic material from Danish. When the same agent speaker speaks Faro-Danish as an L2, s/he performs a push-chain, and imposes linguistic material from Faroese onto Faro-Danish.

For example, the low-level attachment pattern *vil ikke* ('will not') in Faro-Danish reveals that constructions are not only indexical. Thus, *vil ikke* (based on the Faroese *vil ikki*) does not point to the *ikke vil* construction in Danish. Hence, *vil ikke* can be interpreted as a diagrammatic reconstruction of a set of values (especially beliefs) mobilized by the agent conceptualizer to facilitate the distribution of agency. The example, used by Petersen (2011: 12), illustrates this point.

(9) a. En meget interessant mand, som mange mennesker vil ikke høre om.
b. (Petersen's Faroese translation) Ein ógviliga áhugaverdur maður, sum nógv fólk vilja ikki hoyra um.
['A very interesting man many people do not want to hear about']

Here, the informant, a 16-year-old person, uses *vil ikke* as a diagram (a low-level attachment pattern) connecting both the Faroese and Danish sign systems. This is accomplished by an iconic operation whereby the syntactic component of

subordinate clause in Faroese is reconstructed in Faro-Danish as a means to express a positive evaluation about someone (in this case an American preacher). Seen through the lens of intelligent agency, we can consider specific examples of semiotic processes governed by agency construction as follows.

Iconicity in agency construction

In the case of iconic agency, we can define the variational free energy (F_iconic) as follows:

$$F\_\text{iconic} = D\_\text{KL}\left(q\_\text{iconic} \| P\left(s\_\text{iconic}, e\_\text{iconic}\right)\right) - \ln P\left(e\_\text{iconic}\right)$$

Here, q_iconic represents the approximate posterior distribution over the beliefs about iconic agency (s_iconic), and P(s_iconic, e_iconic) is the true joint distribution of beliefs and sensory evidence associated with iconic agency. The second term, ln P(e_iconic), captures the evidence likelihood.

To update the beliefs about iconic agency, we can use the following update equation:

$$q\_\text{iconic}\left(s\_\text{iconic}\right) \propto \exp\left(-\beta * F\_\text{iconic}\right)$$

Here, β represents the precision or learning rate that determines the rate of belief updating. By minimizing F_iconic, the beliefs are iteratively updated to align with the observed sensory evidence, leading to a better approximation of the true posterior distribution.

Indexicality in agency construction

For indexical agency, the variational free energy (F_indexical) can be defined similarly:

$$F\_\text{indexical} = D\_\text{KL}\left(q\_\text{indexical} \| P\left(s\_\text{indexical}, e\_\text{indexical}\right)\right) - \ln P\left(e\_\text{indexical}\right)$$

Here, q_indexical represents the approximate posterior distribution over the beliefs about indexical agency (s_indexical), and P(s_indexical, e_indexical) is the true joint distribution of beliefs and sensory evidence associated with indexical agency. The second term, ln P(e_indexical), captures the evidence likelihood.

The update equation for updating the beliefs about indexical agency is as follows:

$$q\_\text{indexical}(s\_\text{indexical}) \propto \exp(-\beta * F\_\text{indexical})$$

By minimizing F_indexical, the beliefs about indexical agency are adjusted to better match the observed sensory evidence.

Symbolicity in agency construction

In the case of symbolic agency, we can define the variational free energy (F_symbolic) as follows:

$$F\_\text{symbolic} = D\_\text{KL}(q\_\text{symbolic} \parallel P(s\_\text{symbolic}, e\_\text{symbolic})) - \ln P(e\_\text{symbolic})$$

Here, q_symbolic represents the approximate posterior distribution over the beliefs about symbolic agency (s_symbolic), and P(s_symbolic, e_symbolic) is the true joint distribution of beliefs and sensory evidence associated with symbolic agency. The second term, ln P(e_symbolic), captures the evidence likelihood.

The update equation for adjusting the beliefs about symbolic agency is as follows:

$$q\_\text{symbolic}(s\_\text{symbolic}) \propto \exp(-\beta * F\_\text{symbolic})$$

By minimizing F_symbolic, the beliefs about symbolic agency are updated to align with the observed sensory evidence.

These equations capture the core principles of active inference and demonstrate how beliefs about agency construction are optimized through the minimization of free energy. By iteratively updating the beliefs based on sensory evidence, the speakers can align their beliefs with the observed world, as a means to incorporate iconicity, indexicality, and symbolicity in the construction of agency in languages like Icelandic and Faroese.

5 Conclusions

This paper has introduced an updated perspective of *Agentive Cognitive Construction Grammar* (AgCCxG) through a focus on the interplay between mind and language from an Active Inference viewpoint and the Peircean theory of signs. Therefore, AgCCxG stresses the influence of intention and purpose on linguistic choices and emphasizes a cognitive nature rooted in maintaining equilibrium between a

symbolic Self and the dynamics of the environment. In this view, linguistic constructions are deemed to encapsulate experienced interactions with the world through reenactment routines acquired via multisensory channels. *Constructional Attachment Patterns*, particularly argument structure constructions, abstractly capture embodied signals through mechanisms involving proprioception, interoception, and exteroception that provide suitable representations of reality. Unlike usage-based approaches which can be hardly considered as true theories of mind and language (contra Cappelle 2024), AgCCxG adopts a robust theory of signs that describes human representation as a continuous process of semiotic hybridization aimed at reducing uncertainty. This implies that agents, by definition, are creative cognizers capable of predicting highly incongruent scenarios that deviate the predictions of current generative models. Moreover, AgCCxG challenges the traditional view of the mind as a unified, rational uncertainty-reducing machine by showing the ways how physical processes governing open biological systems profoundly influence the linguistic sign system. The adaptability of intelligent agents in manipulating language to express incongruous realities underscores the role of semiotic hybridization in preserving autonomy and semiotic boundary.

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