Rethinking Linguistic Structures as Dynamic Tensegrities

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Abstract

Constructional approaches to language have evolved from rigid tree-based representations to framing constructions as flexible, multidimensional pairings of form and function. However, it remains unclear how to formalize this conceptual shift in ways that are both computationally scalable and scientifically insightful. This paper proposes *dynamic tensegrity* – a term derived from "tensile integrity" – as a novel architecture metaphor for modelling linguistic form. It argues that linguistic structure emerges from dynamically evolving networks of constraint-based tensions rather than fixed hierarchies. The paper explores the theoretical consequences of this view, supplemented with a proof-of-concept implementation in Fluid Construction Grammar, demonstrating how a tensegrity-inspired approach can support robustness and adaptivity in language processing.

1 Introduction

Since its conception in the 1980s, Construction Grammar has evolved from a bold challenger of the field's core-periphery distinction into one of the most widely adopted frameworks in contemporary linguistics. The **constructional idea** – that all linguistic knowledge can be described as pairings of form and function, called *constructions* – collapsed the traditional boundaries between rules and exceptions, and between lexicon and grammar (Fillmore, 1988, 1989; Fillmore et al., 1988).

As the field shifted from more traditional, static descriptions towards dynamic usage-based approaches (Bybee and Thompson, 2000; Langacker, 2000; Goldberg, 2006), the initial conception of constructions as constituent trees was replaced by a view of them as multidimensional structures (Fried and Östman, 2004; van Trijp, 2016; Goldberg, 2019). However, it has proven difficult to formalize this conceptual shift in a computationally scalable and scientifically interpretable way.

Most current analyses in construction grammar still rely on tree-like or slot-filler architectures inherited from earlier paradigms. While these models are useful for static descriptions of linguistic structure, they are not adapted for handling the fluidity and adaptivity required for usage-based models. In response, several researchers have begun to investigate the relevance of Large Language Models (LLMs; Goldberg, 2024; Piantadosi, 2024); but although LLMs undeniably offer new possibilities, their lack of explicit structures makes them difficult to interpret – particularly for formulating scientific generalizations about how constructions contribute to meaning-making in situated interactions.

This paper aims to complement this modeling landscape by offering an explicit, constraint-based account of linguistic structure that unifies fluidity and robustness, while remaining fully interpretable for the human researcher. More specifically, we propose *dynamic tensegrity* – a structural principle used in architecture, robotics, and some biological models to explain how systems maintain stability through distributed tension and compression – as a novel metaphor for describing linguistic form.

Rather than representing linguistic structure as a rigid hierarchy, we model it as an evolving network of interdependent constraints held in a dynamic equilibrium. In this view, constructions combine to build structures that self-stabilize through ongoing resolution of interdependent morphosyntactic, semantic and pragmatic constraints, much like tensegrity structures distribute mechanical forces across the system to preserve structural balance.

We explore the theoretical consequences of this reframing and present a proof-of-concept implementation in Fluid Construction Grammar (FCG Steels, 2004, 2011; van Trijp et al., 2022; Beuls and Van Eecke, 2026), an open-source computational platform explicitly designed for developing adaptive yet robust models of language processing.

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2 The Case for Constructional Integrity

All complex systems – whether biological, architectural or computational – require components that can sustain their *integrity* under dynamic conditions. In linguistics, however, integrity has often been misinterpreted as rigidity: as something that must remain fixed or untouched. In reality, integrity is what enables a system to maintain structural coherence while remaining flexible enough to function under pressure. In this section, we argue that this systems-level insight requires us to rethink the nature of grammatical structure. We propose **constructional integrity** as a foundational principle that explains how language can be both stable and adaptive – capable of preserving meaningful structure while dynamically responding to the demands of communication.

2.1 Integrity Misunderstood

During the heydays of transformational syntax, Noam Chomsky (1970) famously introduced the "lexicalist hypothesis", proposing a strict separation between word formation (morphology) and sentence formation (syntax). According to this view, the morphological component produces lexical items as ready-made parts, which are then arranged into syntactic configurations by phrase structure rules and transformations. By enriching the lexicon and minimizing the burden on syntax, Chomsky aimed to advance his broader goal of developing a theory of Universal Grammar.

The Lexicalist Hypothesis influenced the field far beyond transformational syntax, and led to the formulation of the **Lexical Integrity Principle** (Wasow, 1977; Lapointe, 1980), which Haspelmath and Sims (2010, p. 203) define as follows:

> "Rules of syntax can refer/apply to entire words or the properties of entire words, but not to the internal parts of their words or their properties."

The Lexical Integrity Principle is committed to rigidity: words are treated as atomic units that can be rearranged but not internally modified. At first glance, this seems plausible. Words do exhibit a cohesiveness that larger structures seem to lack. Take the sentences in (1), from Goldberg (2006, p. 21), which preserve the same underlying argument structure – an agent (*Nina*) transferring a patient (*a dozen flowers*) to a recipient (*her mother*) – despite differences in surface order.

(1) a. Nina sent her mother a dozen flowers.
b. A dozen flowers, Nina sent her mother!

In lexicalist approaches, these argument structure relations are already determined in the meaning of the verb. Surface alternations are then explained through transformations of a shared deep structure (e.g. Haegeman, 1994), or through lexical rules that modify the verb's syntactic behaviour (Briscoe and Copestake, 1999).

Constructional approaches, however, take a different view. According to Goldberg (2006), the argument structure relations in both sentences are contributed not by the verb alone, but by the Ditransitive construction – a more abstract argument structure construction that expresses Caused-Transfer semantics. Word order differences are attributed to the interaction of this construction with others – such as the topicalization construction – to satisfy discourse-pragmatic needs. In this view, meaning and structure are not projected from verb-centered templates, but emerge from the dynamic composition of constructions in context.

More importantly, the constructional view does not treat the Ditransitive construction as a rigid, phrase-structural template. Instead, it assumes a high degree of structural flexibility: the construction can be used in various configurations, such as topicalization or clefting, while preserving its core semantic function of indicating who does what to whom.

This kind of flexibility requires a form of integrity that we observe in living systems as well: the ability to maintain functional coherence while adapting to functional pressures. A clear illustration is the biological cell. As Huang et al. (2006, p. 290) note, "death of both cells and whole organisms is characterized by a rapid increase in rigidity (*rigor mortis*), with a complete loss of the flexibility that dominates the living state. Thus, this unification of *robustness* with *flexibility*, both in terms of cell structure and behavior, is a hallmark of complex living systems."

Crucially, while the rigid principle of Lexical Integrity has already been shown to be empirically inadequate (Bruening, 2018), we will argue that this kind of dynamic integrity is not a property of the lexicon alone, but of *all* constructions more broadly – including those that handle argument structure, information packaging, and discourse-level coordination.

2.2 Constructional Integrity in Action

Let's illustrate Constructional Integrity through some examples, starting with (2), which shows ellipsis in the coordination between *hand-drawn* and *computer-drawn*:

(2) Do you prefer *hand- or computer-drawn* animation?

This example violates the Lexical Integrity Principle, which prohibits syntactic operations from tampering with the internal structure of words. Here, the coordination construction must elide the second component of *hand-drawn*.

From the perspective of Constructional Integrity, however, such cases are not exceptions anymore. Constructions are mappings between form and function, where the form itself plays a *diagnostic* role: it enables language users to detect which constructional knowledge to activate (Croft, 2001). Morphological constructions are typically recognizable by their specific arrangement of phonemes, while syntactic constructions – such as the English passive construction – are typically recognizable by surface patterns (e.g. auxiliary-*have* + *ed*-participle).

In most contexts, removing *drawn* from *hand-drawn* would indeed be detrimental: it would render the construction unrecognizable, disrupting its communicative function. In the coordinated phrase in (2), however, functional integrity is preserved. The structural "load" is shared with *computer-drawn*, which enables the listener to reliably reconstruct the full concept underlying *hand-drawn* despite the omission.

Moreover, the ellipsis construction adds new functionality on its own: it avoids repetition while sharpening the contrast between *hand* and *computer* – highlighting the most salient distinction of the speaker's question. The interplay between ellipsis and compounding here exemplifies constructional integrity in practice: flexible form (even for words), robust meaning.

Now, let's explore another example that shows how constructional flexibility is needed for guiding semantic interpretation in ways that is often missed by word + syntax approaches. Consider example (3), which is typically analyzed in terms of "filler-gap" mechanisms (Sag, 2010):

(3) Do you remember the song that Jack loves?

A standard filler-gap analysis is that the Object *the song* has been "extracted" from its canonical position in an underlying structure like *Jack loves the song*, leaving a silent "gap" behind. But this view presupposes that the sentence is derived from a more basic configuration – and more importantly: it misrepresents the semantics and fails to explain *why* this structure exists in the first place.

What the formal account overlooks is the function of *the song* as a noun phrase. Typically, a definite noun phrase signals that its referent is identifiable (Lambrecht, 1994). If I say *Jack loves the song*, I imply that *the song* alone is sufficient to know which song I am talking about. Yet, in example (3), that is not the case. The only way to identify the song in question is precisely by saying that Jack loves it.

To resolve this, English speakers have invented what we might call a Möbius strip construction: a structure in which the intended interpretation emerges through interconnection rather than strict syntactic hierarchy. Breaking this process down:

1. A definite noun phrase must establish a uniquely identifiable referent. Here, *the song* alone fails to do so. Ironically, this means that the phrase *Jack loves the song* cannot possibly have served as the extraction site: it ticks all checkboxes of syntactic well-formedness, but it is pragmatically incomplete in the current context because its Object NP cannot fulfil its referential function.

2. To restore its functionality, the noun phrase must integrate the transitive clause as post-nominal modifier, effectively "recruiting" it to establish reference (and maintaining its own functional integrity).

3. Because the transitive clause is now embedded within the noun phrase, the object no longer needs to be realized in post-verbal position – it is structurally distributed. This allows the transitive construction to sustain its functional integrity, even as it supports the referential work of the noun phrase.

All of the above illustrates how formal flexibility is not just permitted but sometimes required to maintain functional integrity. Rather than treating structures like (3) as derivations, we should recognize them as adaptations that balance syntactic constraints with communicative needs.

3 Linguistic Form as Dynamic Tensegrity

We just argued that *constructional integrity* is a necessary condition for modelling language as a dynamic, adaptive system. But how can we achieve such integrity in a formal architecture?

We propose **dynamic tensegrity** as a novel architectural metaphor for linguistic form: a system in which constructions interact through interdependent constraints held in dynamic equilibrium.

This section introduces the concept of dynamic tensegrity and explores how it may inform both the theoretical understanding and computational implementation of construction grammar.

3.1 What is Tensegrity?

The term *tensegrity* – short for "tensile integrity" – was first coined by Buckminster Fuller in the mid-20th century to describe an architectural principle in which structural stability arises from the interaction between elements under continuous tension and elements under localized compression (Swanson, 2013). The concept was directly inspired by the sculptural artwork of Kenneth Snelson, a student of Fuller, whose pioneering constructions gave the idea physical form.

Figure 1 illustrates this principle through Snelson's artwork *Tree I*, a suspended structure composed of rigid struts (under compression) and flexible cables (under tension). In a true tensegrity, the struts never touch; they are held in place entirely by the pull of the tensile network. What looks improbable – floating beams in open space – is in fact a precisely tuned equilibrium, where no single element holds the structure together, but the system as a whole sustains its integrity.

Tensegrity exemplifies how complex systems can be resilient without rigidity, and stable without central control – a principle that has found wide applications not only in architecture, but also in robotics (Shah et al., 2022) and biology (Huang et al., 2006; Swanson, 2013).

3.2 Systems within Systems within Systems

The principle of tensegrity has become a powerful heuristic in biomechanics, offering insights across multiple scales of organization – from cells and tissues to organs and whole organisms. This nested hierarchy – "tiers of systems within systems within systems" (Ingber, 2003, p. 1167), with emergent properties at each level – will serve as our architectural model for language.

Figure 1: *Tree I* by Kenneth Snelson. Photo available via Wikimedia Commons, licensed under CC BY-SA 4.0.[1] Image scaled for formatting; no other changes.

The most intuitive application of tensegrity is at the level of the organism. Humans walk, stand, and move their bodies thanks to the musculoskeletal system, which achieves structural stability through the interaction of local compression and continuous tension. In this system, bones bear compression, while muscles, tendons, and ligaments form a tensile network that distributes mechanical stress throughout the body. Crucially, our bones do not directly touch each other for bearing load, but are suspended in a matrix of tension. This distributed arrangement allows the body to absorb shocks, adapt to uneven terrain, and maintain balance. Rather than relying on central control, the system achieves equilibrium through the self-regulating dynamics of its parts. Tensegrity robotics draws directly on these properties, designing systems that are both robust and flexible (Shah et al., 2022).

But tensegrity also applies to other tiers. At the cellular level, for instance, tensegrity may explain how cells retain structural integrity despite constant remodelling in response to external pressure. As Huang et al. (2006) note, the shape and mechanical behavior of mammallian cells are largely governed by an internal scaffold called the "cytoskeleton". In the tensegrity view, this scaffold functions like a dynamic 3D network: filamentous proteins (microfilaments) create tension by pulling inward, while rigid rods (microtubules) push outward to resist compression. Together, these elements form a self-stabilizing system that can deform and reorganize without collapsing.

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[1] `https://creativecommons.org/licenses/by-sa/4.0/deed.en`

Besides observing that tensegrity seems to be a "fundamental design principle that is used to stabilize biological networks at all size scales in the hierarchy of life", Huang et al. (2006, p. 296) argue that tensegrity "may also directly impact information flow in biological systems". In other words, the spatial properties of tensegrities (their *form*) seem strongly interrelated with the *function* of the systems they stabilize.

Form and function co-emerging through distributed tension may also explain how grammatical constructions stabilize meaning. The next step is therefore to see if this structural principle extends from cells to constructions.

3.3 Linguistic Tensegrity Networks

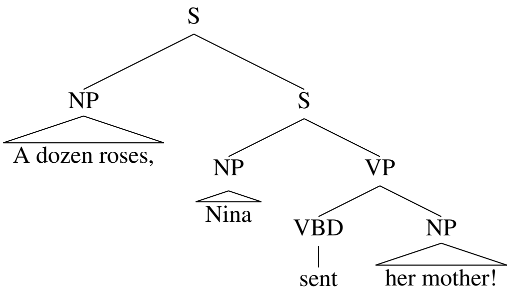
To model linguistic structure as dynamic tensegrities, we must shift from trees to networks: not hierarchical command structures, but lattices of constraint and support.

Network-based thinking already plays a key role in understanding how structure emerges from distributed interaction. In complex adaptive systems, networks model how local interactions give rise to global properties (Yang et al., 2023). In construction grammar, they help chart the usage-based relationships between constructions (Diessel, 2019) and collostructional affinities (Wellens, 2011).

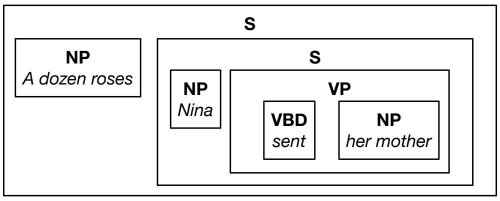
Moreover, networks are suited for describing both *structural* systems and *information processing* systems (Huang et al., 2006). While this paper focuses on structure, tensegrity networks thus offer a promising foundation for modelling the interplay between form and meaning in future research.

Let us start with the familiar tree representation in (4) and its notational variant as boxes-within-boxes in (5).

(4)



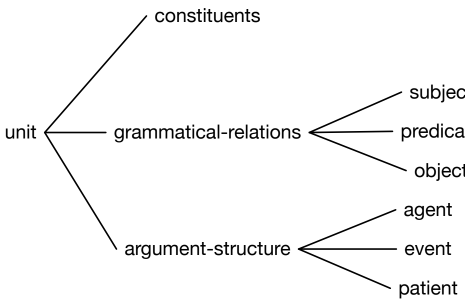
(5)



Although they differ in notation – one emphasizing hierarchy, the other slot-filling – both rest on the same structural assumption that phrase-structural relations form the backbone of linguistic analysis, which can then be enriched with feature-value descriptions. From a mechanical perspective, both representations connect rigid parts directly: structure is assembled by stacking the different building blocks on top of each other. From an information flow perspective, there is a clear entry point to the structure (the root node S); and accessing relevant information requires tree traversal.

By contrast, tensegrity models suggest an alternative: suspension through tension. Structures are not held together by direct contact, but through distributed constraint resolution. Moreover, unlike a tree with a single root and directed paths, a tensegrity-like network behaves more like a city map, offering multiple points of entry and redundant pathways for accessing information.

To formalize this perspective, we reconceptualize the basic components of linguistic structure. Instead of stacking nodes directly on top of each other in a rigid hierarchy, we *suspend* them as separate **compression units**: modular structures that **encapsulate** a coherent set of feature-value pairs. These may describe phonological, morphosyntactic, semantic or pragmatic properties, as illustrated in (6). The unit as a whole behaves as a rigid body: internally structured, but moving or linking like a single entity.



(6)

In this model, constituent structure is not the backbone, but one of many possible descriptions encoded within a compression unit – e.g. using a *constituents* feature. This decoupling allows the model to accommodate the multi-dimensionality of constructions, which often cut across levels in non-uniform ways. Some constructions are compact, engaging with only phonology and morphology. Others reach from the conceptual to the pragmatic. As Fried and Östman (2004, p. 19) put it:

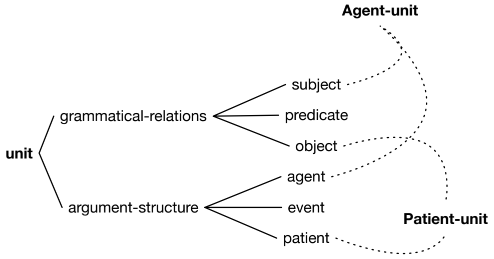
> "Construction Grammar [is] a multi-dimensional framework in which none of the layers is seen as 'more basic' than any other; constructions only differ in the extent to which they make use of these resources."

We now have compression units. But what holds them together? What provides tension?

In our model, tension arises through **unit links**. Rather than filling slots directly or imposing hierarchical dominance, compression units are connected by linking the values of their internal features to other compression units. These unit links define the network of **interdependence**, and thus serve as tension constraints: abstract forces that align and balance feature information across units. In sum, structure no longer emerges through assembly, but through **relational suspension**.

Examples (7) and (8) offer a partial illustration of how English active and passive sentences link compression units in different ways. In our model, the Passive is not treated as a transformation of some underlying active form, but as a **self-contained tensegrity configuration** with its own usage and interpretation conditions.

(7)



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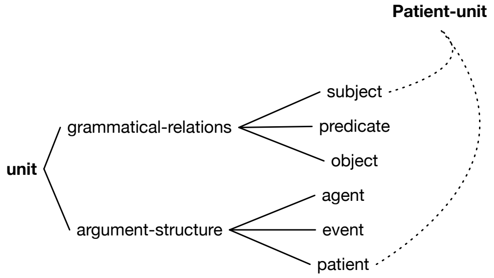

Likewise, the topicalization alternation in sentence pair (1) can now be reinterpreted as two distinct tensegrity configurations. In *A dozen flowers, Nina sent her mother*, the same underlying ditransitive relation holds as in *Nina sent her mother a dozen flowers* – but the compression units associated with the topicalized phrase are reoriented through a different pattern of linking, driven by discourse-pragmatic constraints.

Rather than treating such alternations as mere surface permutations, our models captures them as **structurally distinct yet functionally coherent configurations** within a dynamic network. The crucial difference from transformational approaches is that the latter privilege a single base structure from which others are derived, whereas in a tensegrity model, **all constraints coexist on equal footing**. Each configuration emerges from a unique balance of forces, not a uniform derivational origin.

3.4 Constructions vs. Construction Schemas

Formalized approaches to construction grammar, such as Berkeley Construction Grammar (Fillmore, 2013) and Sign-Based Construction Grammar (Michaelis, 2009), describe constructions as static constraints on well-formed tree configurations or filler-slot relations. In our dynamic tensegrity view, we subscribe to the constraint-based approach, but we further adopt a distinction between constructions – the emergent, conventionalized pairings of form and function observable at the community level – and **construction schemas**, the knowledge that an individual language user has about these constructions.

Construction schemas act as **dynamic operators** that build and combine constructions. More specifically, construction schemas need the following components:

- **Applicability conditions**: These determine when a schema may be invoked, typically based on the presence of certain feature-value pairs across one or more compression units.
- **Linking constraints**: Once activated, the construction schema imposes relational constraints that coordinate values across units. These constraints include unit links – the "tensions" that maintain structural integrity.
- **Contributing part**: The schema may also expand existing units or introduce entirely new compression units – adding structure necessary for stabilizing the evolving network and for satisfying the language user's communicative needs.

For example, the schema for building the English Active-Transitive construction requires the presence of three compression units that represent an event and its agent and patient. In the resulting construction, these units are linked together in a dynamic equilibrium.

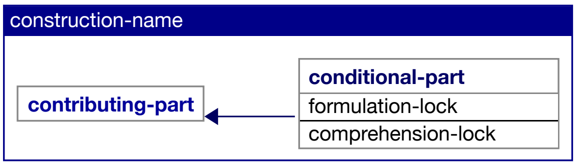

Figure 2: A skeletal representation of a simple construction schema in Fluid Construction Grammar.

4 Modelling Dynamic Tensegrity in Fluid Construction Grammar

Fluid Construction Grammar (FCG) is an open-source computational platform for construction grammar that was originally developed to support experiments in language evolution and emergence (Steels, 2004, 2012). As such, it makes no a priori assumptions about syntactic structure: its architecture is explicitly designed to allow structure to emerge in local usage events.

Another key advantage of FCG is its transparent, symbolic representation of constructions, which are fully inspectable via an interactive web interface (Loetzsch, 2012). Besides its source code, FCG also has a freely available and cross-platform Integrated Development Environment (van Trijp et al., 2022), making it an ideal system for interpretable modelling and hypothesis testing.

Moreover, prior research in FCG has already anticipated several of the architectural intuitions explored in this paper – including the treatment of grammatical structure as dynamic networks rather than rigid trees (Beuls and Steels, 2013; van Trijp, 2016, 2020). The current proposal builds on and extends this work by introducing tensegrity as a unifying metaphor for organizing and linking constructional representations.

4.1 Adopting Tensegrity in FCG

Due to space limitations, this paper focuses on how the tensegrity principle can be adopted within the FCG framework. A working implementation and interactive web demo are available in the supplementary materials.

Figure 2 provides a schematic representation of a construction schema in FCG. Each schema consists of two sides:

- The right-hand side defines the applicability conditions: what must be present in the transient structure to activate the schema.
- The left-hand side provides the contributing part: what information needs to be added.

Each side contains one or multiple boxes – units in FCG parlance – which we reinterpret here as compression units. On the conditional side, each compression unit is further subdivided into two parts: the *formulation-lock* (above) determines the conditions under which the construction can be built in production; while the *comprehension-lock* specifies the necessary cues for recognizing a construction in parsing.

Constructional activation, constraint resolution and contribution are all three achieved through two types of unification processes: matching and merging (Steels and De Beule, 2006). The activation process works by matching the relevant lock's conditions against the **transient structure** – a dynamically evolving representation of the sentence's tensegrity network. If the match is successful, this simultaneously resolves (some) structural tension by unifying variables or completing partial structures. Every successful match is followed by two merging phases: first, the information of the lock is opened and integrated with the transient structure; after which the contributing part is unlocked and integrated as well. The result is an expanded and more stabilized tensegrity network.

4.2 Proof-of-Concept Implementation

In the supplementary materials, the mapping between tensegrity and FCG is illustrated using the following expressions:

(9) a. The rabbit *nibbled* the carrot.
b. The carrot was *nibbled* by a rabbit.
c. A *nibbled* carrot.

Although each example includes the same verb form *nibbled*, traditional analyses consider only (a) as the "basic" verbal form, while (b) and (c) are treated as derivations – respectively, the passive verb form and a deverbal adjective. But this analysis misses important semantic generalizations.

We offer a different interpretation: *nibbled* is never a derived form, but a stable tensegrity network – a local configuration licensed by two constructions: one evoking a semantic frame, the other imposing morpho-aspectual form and semantics.

The NIBBLE-CXN[2] evokes a semantic frame based on the verbal root *nibble*. Following a force-dynamic approach (Talmy, 2000; Croft, 2012), this frame encodes a **causal chain** in which an agent applies force to affect a patient.

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[2] The abbreviation "cxn" stands for "construction".

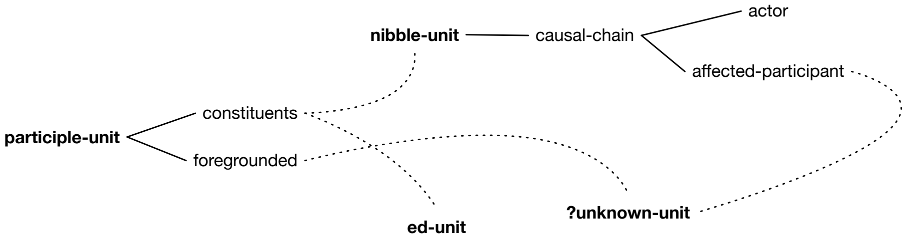
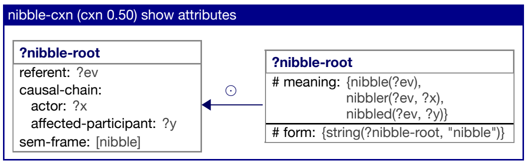


Figure 3: Schematic tensegrity configuration for the verb form “nibbled”. Three compression units – representing the participial form, the verb root, and the morphological suffix – are suspended in dynamic equilibrium by unit links. The structure foregrounds the affected participant but remains underspecified (*?unknown-unit*), allowing integration into multiple grammatical configurations (e.g. passive, nominal).

Example (10) offers a simplified representation of the NIBBLE-CXN schema. In plain words, this construction schema will be activated if the speaker wants to express the Nibble Frame (here represented using first-order predicates in the formulation lock); or if the listener observes the verbal root “nibbles” in comprehension. If matching is successful – that is, a compression unit is found in the transient structure that meets the schema’s conditions – the contributing information is added. In this case, the schema expands the compression unit with additional information.

(10)



```
nibble-cxn (cxn 0.50) show attributes

?nibble-root                              ?nibble-root
referent: ?ev                             # meaning: {nibble(?ev),
causal-chain:                        ⊙                nibbler(?ev, ?x),
  actor: ?x                       ◀────               nibbled(?ev, ?y)}
  affected-participant: ?y                # form: {string(?nibble-root, "nibble")}
sem-frame: [nibble]
```

Moving onto the *ed*-suffix, English *ed*-forms consistently foreground the result state of the event – precisely the point in the causal chain where the patient has been affected. This explains why that *ed*-form naturally fits all three examples: (a) in past tense expressions, the event has been completed; (b) in the passive, the focus is on what happened to the undergoer; and (c) in nominal phrases, the *ed*-form identifies the noun as the affected participant.

We therefore model the -ED-PARTICIPLE-CXN as a morpho-aspectual construction: it contributes the surface form “nibbled”, and constrains interpretation to highlight the affected participant. In comprehension, its construction schema is activated as soon as a verbal root is encountered followed by the -*ed*-suffix.

The result of combining these two constructions is schematically represented in Figure 3. As can be seen, three compression units are suspended (*participle-unit*, *nibble-unit* and *ed-unit*), held in tension by two unit links going from the participle-unit’s constituent feature to the other two units. However, in order to reach full equilibrium, the tensegrity configuration still needs a fourth compression unit (here mentioned using the placeholder variable *?unknown-unit*), indicating that the affected participant is foregrounded by this tensegrity structure. This underspecified unit allows the construction to be integrated in various other tensegrity configurations, such as passive and nominal networks.

This illustrates the central advantage of tensegrity: grammatical structure emerges not from derivational rules, but from locally stable networks of constraints that can be “pulled” or reoriented – robust, flexible, and transparently interpretable.

5 Conclusion

This paper made the case for **constructional integrity** as a necessary condition for modelling language as a complex adaptive system. It then introduced **dynamic tensegrity** as a novel metaphor and modelling principle for ensuring structural integrity in construction grammar.

By shifting from stacked trees to suspended networks, we offered a structural account of grammar that promises both robustness and flexibility without derivations. Our formalization reframes construction schemas as constraint-resolving operators within a tensegrity network of compression units and linking tensions. We supplemented the approach with a proof-of-concept implementation in Fluid Construction Grammar.

The principle of tensegrity complements the constructional modelling landscape by aligning with usage-based, multidimensional views of grammar while remaining human interpretable. Future work may focus on how tensegrity may also stabilize the semantic functions of constructions.

Acknowledgments

The core idea for this paper grew out of discussions about tensegrity robotics with my colleagues David Colliaux, Peter Hanappe and Sébastien Marino; and could not have blossomed without the mentorship of Luc Steels, and the many years of collaboration with the FCG community, particularly Katrien Beuls and Paul Van Eecke. I also thank Peter Hanappe, Hiroaki Kitano, Vittorio Loreto and all my colleagues for creating such a superb working environment.

Supplementary Materials

The demonstration that supports this paper can be downloaded at: `https://zenodo.org/records/15778283`. The file can be loaded and tested with the FCG Editor, available at `https://fcg-net.org`.

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