

# Return Under Constraint

A Theory of Persistence in Language, Ritual, and Form

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## Abstract

This essay develops a general account of persistence across domains: linguistic, ritual, and technological. The central claim is that stability is not a property of unchanging objects but a dynamical achievement, arising when structure is repeatedly reconstituted under constraint. We introduce the *Constraint–Recurrence Principle*, state it formally, and demonstrate its operation through three worked examples: the Arabic root  $\text{ق ر ا}$  (q-r-ā), whose semantic field encodes structured return; the Talbiya, whose iterative invocation enforces alignment of the subject under a singular constraint; and movable type printing, in which discrete symbolic units are repeatedly arranged and impressed to preserve form across iterations. We formalize the principle using a composite operator on an admissibility space, characterize its fixed points as stable configurations, and catalog the failure modes that arise when constraint and recurrence are decoupled. The essay argues that these domains converge not because of shared historical origin, but because any system that must preserve meaning across time is subject to the same structural requirement: what persists is that which returns under constraint.

## Contents

<b>1</b>	<b>Introduction: The Problem of Persistence</b>	<b>3</b>
1.1	The Illusion of Static Stability . . . . .	3
1.2	Persistence as a Dynamical Problem . . . . .	3
1.3	Preview of the Constraint–Recurrence Principle . . . . .	3
1.4	Method and Scope . . . . .	4
<b>2</b>	<b>Positioning: Distinction from Existing Frameworks</b>	<b>4</b>
2.1	Information Theory and Transmission . . . . .	5
2.2	Dynamical Systems and Stability . . . . .	5
2.3	Structural Linguistics and Semantic Fields . . . . .	6
2.4	Cybernetics and Feedback Systems . . . . .	6
2.5	Summary of the Distinction . . . . .	6
<b>3</b>	<b>From Meaning to Mechanism: The Limits of Static Semantics</b>	<b>7</b>
3.1	Words as Lists versus Words as Processes . . . . .	7
3.2	Semantic Fields as Dynamical Systems . . . . .	8
3.3	Compression of Structure into Lexical Form . . . . .	8
<b>4</b>	<b>The Root ق ر أ as Structured Recurrence</b>	<b>8</b>
4.1	The Semantic Range of ق ر أ . . . . .	8
4.2	Unification Through Recurrence . . . . .	9
4.3	Boundary-Indexed Meaning and Cyclical Phases . . . . .	9
4.4	Linguistic Compression of Dynamical Invariants . . . . .	10
<b>5</b>	<b>Oath, Cycle, and Temporal Anchoring</b>	<b>10</b>
5.1	The Structure of the Qur’anic Oath . . . . .	10
5.2	Cyclical Phenomena as Epistemic Anchors . . . . .	11
5.3	Constraint and Recurrence as Complementary Structures . . . . .	11
5.4	Convergence Without Descent . . . . .	12

<b>6</b>	<b>Invocation and Declaration: Stabilizing the Subject</b>	<b>12</b>
6.1	The Talbiya as Iterative Alignment . . . . .	12
6.2	Exclusivity and Closure . . . . .	13
6.3	Declaration as Fixed-Point Assertion . . . . .	13
6.4	The Subject as a Dynamical System . . . . .	13
<b>7</b>	<b>Technological Realization: Printing and Reproducibility</b>	<b>14</b>
7.1	Discretization of Form . . . . .	14
7.2	Constraint Through Arrangement . . . . .	14
7.3	Recurrence Through Iterative Impression . . . . .	15
7.4	Stability as Reproducibility . . . . .	15
<b>8</b>	<b>Formalization: The Constraint–Recurrence Principle</b>	<b>15</b>
8.1	Definitions . . . . .	15
8.2	Fixed Points and Stability . . . . .	16
8.3	Entropy-Based Reformulation . . . . .	16
8.4	Relation to RSVP Fields . . . . .	17
<b>9</b>	<b>Identity as Fixed Point Under Constraint</b>	<b>18</b>
9.1	From Sameness to Invariance . . . . .	18
9.2	Identity Across Domains . . . . .	18
9.3	Identity and Perturbation . . . . .	19
9.4	Multiplicity and Identity Classes . . . . .	19
9.5	Identity as Process, Not Substance . . . . .	20
9.6	Final Remark . . . . .	20
<b>10</b>	<b>Failure Modes and Limits of Stability</b>	<b>20</b>
10.1	Drift: Recurrence Without Constraint . . . . .	20
10.2	Rigidity: Constraint Without Recurrence . . . . .	21
10.3	Oscillation: Non-Convergent Dynamics . . . . .	21
10.4	Obstruction: Incompatible Constraints . . . . .	21

10.5	Local Minima and False Stability . . . . .	22
<b>11</b>	<b>Worked Examples</b>	<b>22</b>
11.1	The Root أ ر أ: Semantic Compression of Recurrence . . . . .	22
11.2	The Talbiya: Subject Stabilization Under Constraint . . . . .	23
11.3	Movable Type Printing: Material Recurrence of Symbolic Form . . . . .	24
<b>12</b>	<b>Semantic Compression and Memplex Structure</b>	<b>25</b>
12.1	Roots as Encoded Operators . . . . .	25
12.2	Ritual as Iterative Constraint Enforcement . . . . .	25
12.3	Media as Recurrence Infrastructure . . . . .	25
<b>13</b>	<b>Convergence Across Domains</b>	<b>26</b>
13.1	Why Similar Structures Reappear . . . . .	26
13.2	Against Naïve Etymological Unification . . . . .	27
13.3	Toward a General Theory of Structural Persistence . . . . .	27
<b>14</b>	<b>Implications</b>	<b>27</b>
14.1	Epistemology: Truth as Stability Under Recurrence . . . . .	27
14.2	Cognition: Memory as Reinstantiation . . . . .	28
14.3	Technology: Reproducibility as Persistence . . . . .	28
14.4	Artificial Intelligence: Alignment and Failure Modes . . . . .	29
<b>15</b>	<b>Conclusion: Return Under Constraint</b>	<b>29</b>
15.1	Restatement of the Principle . . . . .	29
15.2	Unification of Examples . . . . .	30
15.3	A Physical Illustration: Rain on the Screen . . . . .	30
15.4	Final Formulation . . . . .	31
<b>A</b>	<b>Mathematical Details</b>	<b>31</b>
A.1	Banach Fixed-Point Theorem . . . . .	31
A.2	Operator Properties . . . . .	32

A.3	Convergence Conditions . . . . .	32
<b>B</b>	<b>Linguistic Notes</b>	<b>33</b>
B.1	On the Root ق ر أ . . . . .	33
B.2	On Structural Comparison . . . . .	33
<b>C</b>	<b>Extended Examples</b>	<b>33</b>
C.1	Reconstruction Systems and Constraint Closure . . . . .	33

## **Introduction: The Problem of Persistence**

### **The Illusion of Static Stability**

The common conception of stability is one of resistance to change: a thing is stable if it stays the same, and unstable if it does not. This picture is intuitive, but it misleads. The objects most reliably experienced as stable — a spoken language, a ritual form, a printed text — are not static. They are reproduced, re-enacted, and reconstituted continuously. What we call stability in these cases is better described as successful recurrence: the capacity of a structure to reconstitute itself across time without losing its defining form.

The stone is stable in one sense; the flame is stable in another. Both resist perturbation, but by entirely different means. The stone resists by mass and rigidity; the flame by continuous reconstitution of its own process. The structures of primary interest in this essay are of the second kind. They persist not because they are fixed, but because they reliably return.

### **Persistence as a Dynamical Problem**

To treat persistence dynamically is to ask not what something is, but how it is maintained. This shift has significant consequences. It means that the question of identity across time is not simply a matter of sameness — whether a thing at  $t_1$  is the same as the thing at  $t_2$  — but a matter of process: what operations ensure that the configuration at  $t_2$  is a recognizable reconstitution of the configuration at  $t_1$ .

This reframing connects the problem of persistence to questions in dynamical systems theory, where stability is defined in terms of convergence under iteration rather than in terms of invariant properties. A system is stable in the Lyapunov sense not because it does not move, but because perturbations do not amplify. We will use this dynamical vocabulary throughout, but apply it to domains — semantics, ritual, technology — where it has not typically been deployed.

### **Preview of the Constraint–Recurrence Principle**

The central claim of this essay may be stated informally as follows.

A structure persists if it reliably returns to itself under constraint.

Two components are essential. *Recurrence* provides the mechanism of return: the structure is reinstated through utterance, enactment, or reproduction. *Constraint* provides the condition of identity: the return must land within an admissible region, not merely produce repetition of any form. Neither component alone is sufficient. Recurrence without constraint produces drift; constraint without recurrence produces rigidity. Only their composition produces the kind of stable, adaptive persistence that characterizes living linguistic and cultural systems.

We will formalize this as an operator equation, characterize its fixed points, and demonstrate its operation through worked examples.

### **Method and Scope**

The essay proceeds by examining three domains in which the Constraint–Recurrence Principle is operative: a lexical root in Arabic, a liturgical formula, and a printing technology. These are not chosen because they share a historical origin or a linguistic lineage. They are chosen because they instantiate the same dynamical pattern under different material conditions.

The comparison is therefore structural, not genealogical. The claim is convergence, not descent. This distinction will be made explicit in the discussion of methodology and again in the conclusion; its importance cannot be overstated, since the strongest objection to cross-domain comparisons of this kind is the suspicion that surface resemblance is being mistaken for deep connection. The reply, which the essay develops in detail, is that the convergence in question is not incidental but necessary: any system that must maintain structure across time under the pressure of variation and entropy is constrained toward solutions of this form.

### **Positioning: Distinction from Existing Frameworks**

The Constraint–Recurrence Principle developed in this essay intersects with several established theoretical frameworks. It is therefore necessary to clarify both its points of contact and its points of departure. The aim is not to reject these frameworks, but to locate the present contribution precisely: it is not a restatement of an existing theory, but a structural synthesis that addresses a different question.

## Information Theory and Transmission

Shannon's information theory provides a formal account of signal transmission under noise. Its central concern is the reliable encoding, transmission, and decoding of messages across a channel with limited capacity. The key quantities — entropy, redundancy, channel capacity — quantify the conditions under which information can be preserved in transit.

The present work addresses a different problem. It is not concerned with the preservation of a message across a channel, but with the preservation of a *structure across iterations*. Transmission theory assumes a message that is already defined and seeks to preserve it under noise. The Constraint–Recurrence Principle addresses how such a message, or structure, maintains its identity when it must be repeatedly re-instantiated.

The distinction may be stated succinctly. Information theory studies the fidelity of transmission. The present theory studies the *stability of identity under recurrence*. The two are related but not reducible to one another.

## Dynamical Systems and Stability

In dynamical systems theory, stability is typically defined in terms of the behavior of trajectories under perturbation. A fixed point is stable if nearby trajectories remain close or converge toward it; Lyapunov stability and asymptotic stability formalize this intuition.

The Constraint–Recurrence Principle adopts the language of fixed points but applies it in a different context. In classical dynamics, the system evolves continuously according to a governing equation, and stability is a property of that evolution. In the present framework, the system is repeatedly *reconstructed* through a composition of constraint and recurrence.

The fixed point here is not merely a state toward which trajectories converge under natural evolution. It is a configuration that is invariant under repeated *reconstitution*. The emphasis shifts from the stability of motion to the stability of *identity across iteration*. This shift is essential for domains such as language, ritual, and media, where the system does not evolve passively but is actively re-instantiated.

## **Structural Linguistics and Semantic Fields**

Structural linguistics, beginning with Saussure, analyzes language as a system of differences without positive terms. Meaning is defined relationally, by position within a network of oppositions. Later developments extend this to semantic fields, in which meanings form structured regions of a conceptual space.

The present work is compatible with this perspective but introduces a dynamical layer. Instead of treating semantic fields as static relational structures, it models them as systems that must maintain coherence under repeated use. A lexical root is not only a position in a structure; it is an operator that generates and stabilizes configurations across contexts.

The claim is therefore stronger than a structural description. It is that certain roots compress dynamical invariants into lexical form, encoding processes of structured return rather than merely occupying positions in a network of differences.

## **Cybernetics and Feedback Systems**

Cybernetics studies systems that regulate themselves through feedback. A system maintains a target state by detecting deviations and applying corrective actions. Negative feedback produces stability; positive feedback produces amplification.

The Constraint–Recurrence Principle may be viewed as a generalization of this idea, but with a crucial difference. In cybernetic systems, feedback operates within a continuous process that maintains a state. In the present framework, stability arises through discrete acts of reconstitution: utterances, impressions, enactments.

Constraint plays a role analogous to feedback, enforcing admissibility conditions. Recurrence provides the iterative mechanism through which these conditions are repeatedly applied. The result is a feedback-like stabilization, but one that operates through *re-instantiation rather than continuous regulation*.

## **Summary of the Distinction**

The theory developed in this essay may be located relative to these frameworks as follows. Information theory addresses the preservation of signals under transmission. Dynamical systems theory addresses the stability of trajectories under evolution. Structural linguistics addresses the relational organization of mean-

ing. Cybernetics addresses the regulation of systems through feedback.

The Constraint–Recurrence Principle addresses a different, though related, problem:

How a structure maintains its identity when it must be repeatedly reconstituted across time.

It does so by identifying the minimal mechanism required for such persistence: the composition of constraint and recurrence. This mechanism appears across domains not because those domains are historically connected, but because any system that must preserve structure under iteration is subject to the same requirement. The contribution of the present work is therefore not to replace existing frameworks, but to identify a structural invariant that operates alongside them, unifying phenomena that they treat separately.

## **From Meaning to Mechanism: The Limits of Static Semantics**

### **Words as Lists versus Words as Processes**

Dictionaries present meanings as lists. A word is assigned an entry; the entry contains numbered senses, arranged from primary to peripheral. This format implies that meaning is a property of the word itself — that the word *has* its meanings the way a box has its contents.

The format is useful for navigation, but it obscures the structure of meaning. Many words do not have discrete senses that could be enumerated without remainder; they have a semantic field, a region of possibility that is structured by the processes from which the word emerged and through which it continues to operate. To list the senses of such a word is to project a continuous field onto a discrete sequence, discarding the topological information that makes the field coherent.

The consequences of this distortion are not trivial. When a root is described as having “seven meanings,” the implication is that these meanings are separable and contingently related. But the more careful description is often that the root encodes a single process that manifests differently under different conditions of application. The task of semantics, then, is not to enumerate meanings but to identify the process.

## Semantic Fields as Dynamical Systems

A semantic field may be modeled as a region of a high-dimensional space in which proximity corresponds to relatedness of meaning and trajectories correspond to the extension of meaning from context to context. On this model, a lexical root does not have a list of meanings; it has a central configuration and a set of trajectories along which meaning extends under pressure.

This model allows for the phenomena that list-based semantics handles poorly: polysemy (the same root in different configurations), apparent contradiction (the root indexing opposite phases of a cycle), and diachronic shift (the central configuration moving over time while the root's identity is maintained). All of these are natural in a dynamical picture. A fixed point in a semantic field is a meaning that returns to itself under the normal operations of language use; a trajectory is a sequence of extensions that preserves enough structure to count as the same root.

## Compression of Structure into Lexical Form

The principal theoretical claim of this section is that certain roots compress dynamical invariants into lexical form. They do not name static objects; they encode stable transformation patterns that recur across domains.

This is a strong claim, and it requires defense. The defense proceeds through example. If it can be shown that a root's apparently disparate meanings reduce to a single underlying process schema, and if that schema can be formalized in a way that makes clear why the meanings belong together, then the compression claim is vindicated. The following section provides this demonstration for the Arabic root **ق ر أ**.

## The Root **ق ر أ** as Structured Recurrence

### The Semantic Range of **ق ر أ**

The Arabic root **ق ر أ** (q-r-a) is most commonly translated as "to read" or "to recite." Its range, however, is considerably wider. Among the meanings associated with the root and its derivations are: to read aloud, to recite from memory, to gather or collect (as in assembling dispersed elements), to match portion to portion, to draw near or return after an absence, to recall or bring back to mind, to wait through a bounded interval, and to warn or summon from a threshold

position.

A note written in 2022 captured this range in a form worth preserving:

Read and study, collect, piece it together and know. Match portion to portion. Draw near or go back after being away. Cite, recite, quote. Be behind, held back, or delayed. Wait a month. Get up and warn.

At first encounter, this appears to be a list of unrelated meanings assembled by historical accident. The thesis of this section is that it is not. The meanings form a coherent pattern, and that pattern corresponds to a specific dynamical structure.

### **Unification Through Recurrence**

Each of the meanings associated with ق ر أ instantiates a version of the same underlying process: the ordered reassembly or reactivation of elements across time.

Reading is the sequential assembly of symbols into a coherent text. Recitation is the structured reactivation of a memorized sequence. Gathering is the physical or conceptual assembly of dispersed elements into a whole. Matching is the alignment of one portion against another. Returning after absence is re-entry into a prior configuration. Recollection is the reinstatement of a prior state of knowing. Waiting through an interval is occupying a phase within a recurrent temporal structure. Warning from a threshold is acting at a boundary, a moment of transition between phases.

These are not metaphorically related by the accident of similar sound. They are structurally related because they all instantiate what we may call *structured return*: the reconstitution of an ordered configuration after an interval of absence, dispersal, or displacement. The core of the root is this schema, and the apparent diversity of its meanings reflects the diversity of domains in which the schema can be applied.

### **Boundary-Indexed Meaning and Cyclical Phases**

The most striking evidence for this interpretation comes from the classical Arabic noun قُرْء (qurā), the plural of which, قُرُوء (qurūa), appears in Qur'anic legal contexts. The word admits two apparently opposed interpretations in classical

scholarship: it may refer to the period of menstruation, or to the period of purity between menstruations. Jurists have long noted and debated this ambiguity.

The dynamical account resolves the apparent contradiction. The word does not primarily denote a fixed state; it denotes a bounded phase in a recurring physiological cycle. Different interpreters anchor the term at different points on the same cyclic trajectory: some at the occurrence of the event, others at the interval between occurrences. The opposition is not semantic contradiction but coordinate choice on a cyclic manifold.

Let  $\gamma(t)$  be a cyclic trajectory partitioned into bounded intervals  $\{I_k\}$ . Then  $\text{قُرْء}$  may refer to  $I_k$  (the event itself) or to the transition between  $I_k$  and  $I_{k+1}$  (the interval between events), depending on the phase-indexing convention. What appears as ambiguity is, formally, an underdetermination of the reference frame, not of the object. The underlying structure is entirely determinate.

### Linguistic Compression of Dynamical Invariants

We may now state the theoretical conclusion precisely. The root  $\text{أ ج ر ق}$  does not name a list of distinct meanings. It encodes a dynamical schema: the gathering of elements into an ordered configuration, the maintenance of that configuration across a bounded interval, and the reconstitution of the configuration after displacement. Each lexical meaning is a projection of this schema onto a specific domain — language, memory, time, action, body.

The schema may be compressed into a single phrase: *structured return under constraint*. Reading is return to the text under the constraint of its symbols. Recitation is return to the sequence under the constraint of its order. Recollection is return to a prior configuration under the constraint of what was previously known. The cyclical phase is return to a temporal position under the constraint of the body's rhythm.

This demonstrates that certain roots function as compressed representations of dynamical invariants. They are not lists; they are operators.

## Oath, Cycle, and Temporal Anchoring

### The Structure of the Qur'anic Oath

A distinctive feature of Qur'anic discourse is the use of oaths, known as *qasam*, that invoke natural phenomena: the sun, the dawn, the night, the moon. These

oaths are not merely rhetorical intensifiers. They perform a specific structural function: they anchor a proposition in a referent that is publicly observable, reliably recurrent, and resistant to subjective variation.

An oath, in its most general form, is a constraint operator. It binds a statement to a condition that persists beyond the moment of utterance, imposing continuity of meaning across time. The force of the oath is not derived from the referent's content — what the moon is — but from its structural properties: recurrence, regularity, and public accessibility.

### **Cyclical Phenomena as Epistemic Anchors**

The moon is selected as an object of oath not because of metaphysical priority, but because of structural appropriateness. Its phases constitute one of the most reliable and publicly visible cyclic structures available to human experience. It partitions time into recurring intervals, provides a natural basis for calendrical organization, and offers a low-entropy reference frame that all observers can share.

When the Qur'an says *كَلَّا وَالْقَمَرَ* ("nay, by the moon"), it is selecting a natural recurrence operator as the ground for a claim that must hold across time. The moon's reliability warrants the reliability of what is asserted. This is not a claim about the moon's ontological status but about its functional role as a temporal substrate.

### **Constraint and Recurrence as Complementary Structures**

The oath imposes a constraint; the cycle provides the recurrence. Together, they form the minimal pair required for the stabilization of a proposition across time.

Without the constraint of the oath, the claim floats free, subject to revision under any pressure. Without the recurrence of the cycle, the constraint has no temporal substrate to anchor it: the claim is binding in a single moment but has no mechanism for being revalidated across successive moments. Their conjunction ensures that the claim is both binding (constraint) and persistently verifiable (recurrence).

This structural complementarity — oath as constraint, cycle as recurrence — anticipates the formal treatment of Section 8.

## Convergence Without Descent

It is essential to note explicitly that nothing in this analysis implies a historical connection between the oath structures of Qur'anic discourse and the temporal semantics of the root ق ر أ. The claim is that both instantiate the same structural pattern. Roots encode recurrence in semantic structure; oaths use cycles to anchor propositions across time. These are independent realizations of the same underlying principle.

This is a general feature of the argument developed throughout this essay. Similar patterns appear across domains not because they share an origin, but because any system that must stabilize meaning across time is driven toward solutions of this form. The convergence is structural, not genealogical.

## Invocation and Declaration: Stabilizing the Subject

### The Talbiya as Iterative Alignment

The Talbiya is the invocation spoken continuously during the Islamic pilgrimage:

لَبَّيْكَ اللَّهُمَّ لَبَّيْكَ، لَبَّيْكَ لَا شَرِيكَ لَكَ لَبَّيْكَ،  
إِنَّ الْحَمْدَ وَالنِّعْمَةَ لَكَ وَالْمُلْكَ لَا شَرِيكَ لَكَ

*Here I am, O God, here I am. Here I am; You have no partner; here I am. Indeed, all praise and blessing belong to You, and all sovereignty. You have no partner.*

The Talbiya is not a descriptive utterance. It does not convey new propositional content. Its function is performative: it enacts a positioning of the speaker within a constraint structure through repetition. Each recitation of لَبَّيْكَ (“here I am”) is not a new report of the speaker’s presence but a renewed alignment of the speaker under a governing reference.

The repetition is not redundancy. It is iterative enforcement. The alignment declared in the first utterance is re-declared in the second, third, and all subsequent utterances, each repetition reinforcing the convergence toward a stable configuration.

## Exclusivity and Closure

The phrase *لَا شَرِيكَ لَكَ* (“You have no partner”) is not merely theological content appended to the main declaration. It is the constraint operator that gives the recurrence its closure.

Without this clause, the repeated presentation of self could in principle be directed toward multiple referents, distributed across competing allegiances. The clause eliminates this possibility. It restricts the admissible set of alignments to a single reference, enforcing exclusivity. In dynamical terms, it reduces the attractor landscape to a single basin.

This is a general feature of effective constraint operators: they must not merely specify what is admissible but eliminate what is not. The exclusivity clause functions precisely this way.

## Declaration as Fixed-Point Assertion

The utterance “Here I stand” — attributed to Martin Luther at the Diet of Worms — provides a structurally parallel case from a different tradition. The speaker does not argue for a proposition; the speaker locates themselves relative to an invariant and asserts that the location is non-negotiable.

The structural parallel with the Talbiya is not coincidental. Both utterances perform the same operation: they fix the subject relative to a governing constraint. The difference is one of mode. The Talbiya reaches stabilization through iterative recurrence: repeated utterance converges the subject toward a fixed point. The declarative standpoint presents itself as already stabilized: convergence is asserted rather than performed.

Both are governed by the same underlying principle. The subject persists by returning to itself under constraint.

## The Subject as a Dynamical System

Extending the dynamical vocabulary from objects and propositions to persons requires only a modest generalization. Let  $X_n$  denote the configuration of the subject at iteration  $n$ : their orientations, commitments, and positions relative to governing values. A recurrence step is any act of re-declaration, re-enactment, or renewed alignment. A constraint is any condition that restricts admissible configurations to a specified region.

The Talbiya implements the iteration

$$X_{n+1} = \mathcal{R}(\mathcal{C}(X_n))$$

where  $\mathcal{C}$  is the exclusivity constraint (“no partner”) and  $\mathcal{R}$  is the recurrence of utterance. Stability is the condition

$$X^* \text{ such that } \mathcal{R}(\mathcal{C}(X^*)) = X^*.$$

The subject is stabilized when repeated application of the constrained recurrence no longer changes their configuration. This is the dynamical definition of conviction.

## **Technological Realization: Printing and Reproducibility**

### **Discretization of Form**

The earliest account of movable type printing, from eleventh-century China, describes a process of surprising formal clarity. Characters are cut into clay as thin as the edge of a coin; each character forms a single type. The cutting operation is the first essential step: it produces discrete, bounded symbolic units from a continuous medium.

Discretization is not merely a convenience. It is the condition that makes constraint possible. A continuous medium admits infinite variation; a discrete set of types admits only the configurations formed by their arrangement. The cut is a constraint built into the material substrate.

### **Constraint Through Arrangement**

The types are set into an iron frame on an iron plate. The frame enforces positional constraints: types must be placed close together, in the correct spatial relations, within a bounded region. This physical frame is the material instantiation of a constraint operator.

The arrangement must satisfy conditions of symbolic correctness (each type corresponding to a valid character), positional alignment (types in correct spatial relation), and structural completeness (the arrangement instantiating the intended text). The frame ensures that only admissible configurations can be produced.

## Recurrence Through Iterative Impression

Printing as a technology does not produce a single outcome. It produces the same outcome repeatedly. The description specifies that two forms are kept in operation: while one is being impressed onto a surface, the other is being reset. The alternation ensures continuous recurrence.

Each impression is a re-instantiation of the same constrained arrangement. The ink is applied; the plate is pressed; the configuration is transferred. The operation is repeated, and the structure is reproduced. This is the recurrence component: the configuration returns, in each impression, to the same form.

## Stability as Reproducibility

A configuration is stable in the printing sense when repeated impression produces invariant output. If the types are correctly cut and the frame correctly set, each page is a faithful reproduction of every other page produced from the same arrangement. The structure persists across iterations not because it is fixed — the plates are reset, the paper replaced — but because the constrained recurrence of the process reliably reconstitutes it.

This is stability in the same sense as the flame: not resistance to change, but successful reconstitution through change.

## Formalization: The Constraint–Recurrence Principle

### Definitions

Let  $\mathcal{A}$  denote an admissibility space: a complete metric space of candidate configurations, representing possible states of a structured system.

**Definition 8.1** (Constraint Operator). A constraint operator  $\mathcal{C} : \mathcal{A} \rightarrow \mathcal{A}$  is a mapping that enforces admissibility conditions on configurations  $X \in \mathcal{A}$ . It encodes structural, logical, or semantic requirements that admissible states must satisfy.

**Definition 8.2** (Recurrence Operator). A recurrence operator  $\mathcal{R} : \mathcal{A} \rightarrow \mathcal{A}$  is a mapping that re-instantiates or propagates a state across time or iterations. It encodes the mechanism by which a configuration is renewed — through utterance, impression, enactment, or computation.

**Definition 8.3** (Constraint–Recurrence Composition). The composite operator

is

$$\mathcal{T} := \mathcal{R} \circ \mathcal{C},$$

representing the application of constraint followed by recurrence. An iterated trajectory is the sequence  $X_{n+1} = \mathcal{T}(X_n)$  from some initial configuration  $X_0 \in \mathcal{A}$ .

### Fixed Points and Stability

**Theorem 8.4** (Constraint–Recurrence Stabilization). *Let  $\mathcal{A}$  be a complete metric space and suppose  $\mathcal{T} = \mathcal{R} \circ \mathcal{C}$  is a contraction mapping on  $\mathcal{A}$ : that is,*

$$d(\mathcal{T}(X), \mathcal{T}(Y)) \leq k d(X, Y) \quad \text{for all } X, Y \in \mathcal{A},$$

where  $0 \leq k < 1$ . Then there exists a unique fixed point  $X^* \in \mathcal{A}$  such that

$$\mathcal{T}(X^*) = X^*,$$

and for any initial configuration  $X_0 \in \mathcal{A}$ , the sequence  $X_{n+1} = \mathcal{T}(X_n)$  converges to  $X^*$ .

*Proof.* This is an immediate consequence of the Banach fixed-point theorem, applied to the complete metric space  $\mathcal{A}$  under the contraction  $\mathcal{T}$ .  $\square$

*Remark 8.5.* The theorem requires strict contractivity, which may not hold in all cases of interest. The entropy-based generalization developed in Section 8.3 weakens this requirement.

### Entropy-Based Reformulation

For systems where strict contractivity cannot be assumed, we reformulate in terms of an admissibility functional.

**Definition 8.6** (Admissibility Functional). Let  $\mathcal{F} : \mathcal{A} \rightarrow \mathbb{R}_{\geq 0}$  be a functional measuring deviation from constraint satisfaction and structural coherence. Explicitly,

$$\mathcal{F}(X) = \alpha \mathcal{V}(X) + \beta \mathcal{D}(X) + \gamma \mathcal{S}(X),$$

where  $\mathcal{V}(X)$  measures constraint violation,  $\mathcal{D}(X)$  measures structural disorder or fragmentation,  $\mathcal{S}(X)$  measures temporal instability under repetition, and  $\alpha, \beta, \gamma > 0$  are domain-specific weights. Lower values of  $\mathcal{F}$  correspond to higher admissibility.

A recurrence operator  $\mathcal{R}$  is called *non-increasing* with respect to  $\mathcal{F}$  if

$$\mathcal{F}(\mathcal{R}(X)) \leq \mathcal{F}(X) \quad \text{for all } X \in \mathcal{A}.$$

**Theorem 8.7** (Entropy-Based Stabilization). *Assume  $\mathcal{F}$  is bounded below,  $\mathcal{R}$  is continuous and non-increasing with respect to  $\mathcal{F}$ , and the sequence  $X_{n+1} = \mathcal{R}(X_n)$  admits at least one accumulation point. Then any accumulation point  $X^*$  satisfies*

$$\mathcal{R}(X^*) = X^*,$$

*and is therefore a fixed point of the recurrence process.*

*Sketch.* Since  $\mathcal{F}(X_n)$  is non-increasing and bounded below, the sequence of values  $\mathcal{F}(X_n)$  converges. By continuity of  $\mathcal{F} \circ \mathcal{R}$ , any accumulation point  $X^*$  must satisfy  $\mathcal{F}(\mathcal{R}(X^*)) = \mathcal{F}(X^*)$ . If  $\mathcal{R}(X^*) \neq X^*$ , then since  $\mathcal{F}$  is non-increasing, we would have  $\mathcal{F}(\mathcal{R}(X^*)) < \mathcal{F}(X^*)$ , contradicting convergence of  $\mathcal{F}(X_n)$ . Hence  $\mathcal{R}(X^*) = X^*$ .  $\square$

This formulation replaces strict contraction with a weaker requirement: recurrence must not increase disorder or constraint violation. Stability emerges as the system settles into configurations where further recurrence does not reduce  $\mathcal{F}$ .

### Relation to RSVP Fields

Within the Relativistic Scalar–Vector Plenum (RSVP) framework, a state is represented as a triple  $(\Phi, \mathbf{v}, S)$  where  $\Phi$  is a scalar coherence field,  $\mathbf{v}$  is a vector flow field, and  $S$  is an entropy field. The Constraint–Recurrence Principle maps naturally onto this representation.

The constraint operator  $\mathcal{C}$  acts on  $\Phi$ , enforcing semantic or structural coherence. The recurrence operator  $\mathcal{R}$  acts on  $\mathbf{v}$ , governing the flow and propagation of structure across time. The admissibility functional  $\mathcal{F}$  involves  $S$ : stable configurations are those that minimize entropy under repeated application of the composite operator.

A stable configuration  $X^* = (\Phi^*, \mathbf{v}^*, S^*)$  satisfies the field equations of the RSVP system at a fixed point, where further evolution under the composite operator does not change the configuration. This is the field-theoretic characterization of persistence.

## Identity as Fixed Point Under Constraint

The preceding sections have developed a formal account of persistence in terms of constrained recurrence. An immediate consequence of this account is a redefinition of identity. What it means for something to be the same across time is not that it remains unchanged, but that it returns to a configuration that is invariant under the operations that reproduce it.

### From Sameness to Invariance

Classical accounts of identity often assume that persistence consists in the retention of properties. An object at time  $t_1$  is identical to an object at time  $t_2$  if it possesses the same defining features. This view is well-suited to static objects but becomes problematic in domains where the object is continuously reconstituted.

The dynamical account replaces sameness of properties with invariance under transformation. Let  $\mathcal{T} = \mathcal{R} \circ \mathcal{C}$  be the constraint–recurrence operator. A configuration  $X^*$  is identical to itself across iterations if

$$\mathcal{T}(X^*) = X^*.$$

Identity is thus defined as a fixed-point condition. The object persists not because it does not change, but because its changes are such that it returns to the same configuration under the governing operations.

### Identity Across Domains

This formulation applies uniformly across the domains considered in this essay.

In the linguistic case, a word retains its identity not because every utterance is identical, but because each utterance returns to a configuration that satisfies the constraints of the root and the language. Variation in pronunciation, context, and emphasis does not destroy identity so long as the recurrence converges to the same admissible form.

In the ritual case, a practice retains its identity not because each performance is identical, but because each performance reconstitutes the same constrained structure. The Talbiya is not the same utterance each time in a physical sense, but it is the same in the sense that matters: it returns the subject to the same alignment.

In the technological case, a printed text retains its identity across copies not because the material substrate is the same, but because each impression re-instantiates the same constrained arrangement of symbols. The identity of the text is the fixed point of the printing process, not the ink on any particular page.

### **Identity and Perturbation**

The fixed-point formulation also clarifies the role of perturbation. A system may deviate from its stable configuration under external influence, but if it is governed by an effective constraint–recurrence operator, subsequent iterations will return it to the fixed point.

Formally, for  $X$  in a neighborhood of  $X^*$ ,

$$\lim_{n \rightarrow \infty} \mathcal{T}^n(X) = X^*.$$

Identity is therefore not the absence of deviation but the capacity to recover from it. A structure is robustly identical to itself if it lies within the basin of attraction of its fixed point.

This distinguishes stable identity from fragile sameness. A configuration that must remain exactly unchanged to count as the same is not robust; it is brittle. A configuration that can absorb perturbation and return to itself is stable in the stronger, dynamical sense.

### **Multiplicity and Identity Classes**

Not all systems converge to a single fixed point. Some admit multiple stable configurations  $\{X^{*(1)}, X^{*(2)}, \dots\}$ , each invariant under the operator  $\mathcal{T}$ . These correspond to distinct identities within the same system.

In such cases, identity is not a single point but a class of fixed points, each with its own basin of attraction. Transitions between identities require crossing the boundaries between these basins, which may be difficult or impossible under the given constraints. This observation applies to linguistic variation (dialects), ritual variation (schools of practice), and technological standards (formats and protocols). Each stable configuration is an identity in the dynamical sense.

## **Identity as Process, Not Substance**

The general conclusion is that identity is not a substance that persists through time, but a process that maintains itself through recurrence under constraint. The appearance of a persistent object is the trace of this process: what we observe as “the same thing” is a sequence of reconstitutions that converge to the same fixed point.

This view resolves a longstanding tension in the philosophy of identity between continuity and change. A system can change in its material realization at every iteration while remaining identical in the only sense that matters: invariance under the operations that define it.

## **Final Remark**

The redefinition of identity in terms of constrained recurrence is not an additional hypothesis layered onto the theory. It is an immediate consequence of the Constraint–Recurrence Principle. Once persistence is understood dynamically, identity follows.

To be the same is to return, under constraint, to oneself.

## **Failure Modes and Limits of Stability**

The Constraint–Recurrence Principle characterizes the conditions for persistence. An equally important task is characterizing the conditions under which persistence fails. Each failure mode corresponds to a specific breakdown in the relationship between constraint and recurrence.

### **Drift: Recurrence Without Constraint**

If recurrence operates but constraint is absent or ineffective, the system evolves without stabilization. Each iteration introduces variation that is not corrected, and the trajectory diverges from any stable configuration. In linguistic terms, this is semantic drift: a root’s meaning broadens or shifts until it no longer identifies a determinate process schema. In cognitive terms, it is confabulation: the process of reconstitution returns, but it returns to an incorrect configuration because no constraint enforces fidelity. In technological terms, it is entropic degradation: the types wear; the arrangement shifts; the reproductions diverge.

### **Rigidity: Constraint Without Recurrence**

If constraint is applied but recurrence is absent, the system collapses into a static configuration. Stability is achieved, but it is the stability of the frozen: the configuration cannot respond to perturbation, cannot adapt to changed conditions, and has no mechanism for self-renewal. The printed plate that cannot be reset, the ritual form that cannot be re-enacted, the root whose meanings have become fixed to a single sense — these are all examples of constraint without recurrence. The result is not instability but brittleness: fragility to any perturbation that exceeds the rigidity of the fixed form.

### **Oscillation: Non-Convergent Dynamics**

If the composite operator  $\mathcal{T}$  is not contractive, the sequence of iterates may cycle among a finite set of configurations without converging.

$$X_n \in \{X^{(1)}, \dots, X^{(k)}\}, \quad k > 1,$$

with the system alternating periodically or quasi-periodically among these states. This corresponds to unresolved structural tension: the constraint enforces conditions that conflict with the recurrence, so the system is perpetually corrected and perpetually displaced. In ritual terms, this is the oscillation between compliance and resistance; in cognitive terms, it is the cycle of belief and doubt that finds no resting point.

### **Obstruction: Incompatible Constraints**

The most severe failure mode is obstruction: the situation in which no admissible configuration exists that satisfies all constraints simultaneously. This is the case when  $\inf_{X \in \mathcal{A}} \mathcal{F}(X) > 0$ . No trajectory can converge to a fixed point because no fixed point exists. The system continues to evolve under the composite operator, but finds no stable resting state.

In the sheaf-theoretic language developed elsewhere in this research program, obstruction corresponds to a non-vanishing cohomological class  $[\alpha] \in \check{H}^1(X, \mathcal{F})$  that prevents local consistent data from being assembled into a global consistent state. The local constraints are individually satisfiable, but their conjunction is not.

## Local Minima and False Stability

Even when a fixed point exists, convergence may terminate at a local minimum of  $\mathcal{F}$  that is not globally admissible. The system appears stable — further iteration does not move it — but the stable configuration is incorrect. This is the failure mode of premature convergence: the system settles before it has explored enough of the admissibility space to reach a genuinely satisfactory configuration. In linguistic terms, this corresponds to a root whose meaning has stabilized at a peripheral extension rather than its structural core.

## Worked Examples

### The Root أَجْرُ: Semantic Compression of Recurrence

We model the semantic dynamics of the root أَجْرُ formally. Let  $X_n$  denote the semantic configuration of an utterance or interpretive act at iteration  $n$ : the ordered assembly of elements (sounds, symbols, meanings) in a current context of use.

Define the admissibility functional

$$\mathcal{F}(X) = \alpha \mathcal{V}(X) + \beta \mathcal{D}(X) + \gamma \mathcal{S}(X),$$

where  $\mathcal{V}(X)$  measures semantic incoherence in the assembled configuration,  $\mathcal{D}(X)$  measures disorder among the elements, and  $\mathcal{S}(X)$  measures instability under repetition.

A recurrence step consists in re-instantiating the configuration through utterance, re-reading, or recollection:

$$X_{n+1} = \mathcal{R}(X_n) = \mathcal{U}(\mathcal{C}(X_n)),$$

where  $\mathcal{C}$  enforces ordering and semantic admissibility, and  $\mathcal{U}$  propagates the configuration into a new temporal instance.

The key claim is that the semantic field of أَجْرُ corresponds to configurations for which this iteration is non-increasing in  $\mathcal{F}$ . Recitation stabilizes toward an ordered form; reading converges to the text; recollection reinstates the prior state; cyclical interval returns to its phase boundary. All are trajectories under the same operator, converging to fixed points within their respective domains.

The apparent duality of  $\text{قُزْء}$  is resolved as described in Section 4.3. The term indexes a bounded interval on the cyclic trajectory  $\gamma(t) = \bigcup_k I_k$ . Different phase-indexing maps  $\pi_1$  and  $\pi_2$  produce different but equally valid references to the same underlying structure. The fixed point of the semantic system is the recurrent cycle itself, not any particular phase within it.

The worked example confirms the theoretical claim. The root  $\text{أ ر ق}$  is not a list of meanings; it is a compressed operator encoding structured return under constraint across a family of domains.

### The Talbiya: Subject Stabilization Under Constraint

Let  $X_n$  now denote the configuration of the subject: their orientations, commitments, and alignment at iteration  $n$ . A recurrence step is an utterance of the Talbiya. The constraint operator  $\mathcal{C}$  encodes exclusivity: the admissible configurations are those in which the subject is aligned to a singular reference with no competing allegiances.

The admissibility functional is

$$\mathcal{F}(X) = \alpha \mathcal{A}(X) + \beta \mathcal{D}(X) + \gamma \mathcal{S}(X),$$

where  $\mathcal{A}(X)$  measures misalignment relative to the governing invariant,  $\mathcal{D}(X)$  measures dispersion across competing commitments, and  $\mathcal{S}(X)$  measures instability under recurrence.

The Talbiya functions as a stabilizing operator when

$$\mathcal{F}(X_{n+1}) \leq \mathcal{F}(X_n),$$

so that each utterance reduces deviation from aligned configuration. Under the conditions of Theorem 8.7, the sequence converges to a fixed point  $X^*$ : a subject-position that is invariant under further application of the constrained recurrence.

This fixed point is not merely a propositional belief-state. It is a stabilized subject: a configuration of the person that returns to itself under repeated constrained recurrence. This is the dynamical definition of conviction, and the Talbiya is a mechanism for achieving it.

The comparison with “Here I stand” is instructive. The declarative standpoint presents the fixed point as already achieved:  $\mathcal{T}(X^*) = X^*$  is asserted, not

performed. The Talbiya performs the convergence through iteration. Both instantiate the same principle; they differ only in whether stabilization is asserted or enacted.

### **Movable Type Printing: Material Recurrence of Symbolic Form**

Let  $X_n$  denote the configuration of a typeset plate at iteration  $n$ : a finite arrangement of discrete types within a frame. The constraint operator  $\mathcal{C}$  enforces symbolic correctness, positional alignment, and structural completeness. The recurrence operator  $\mathcal{R}$  is the printing action: application of ink and transfer of the configuration to a new surface.

The admissibility functional is

$$\mathcal{F}(X) = \alpha \mathcal{E}(X) + \beta \mathcal{D}(X) + \gamma \mathcal{S}(X),$$

where  $\mathcal{E}(X)$  measures symbolic error,  $\mathcal{D}(X)$  measures spatial misalignment, and  $\mathcal{S}(X)$  measures degradation under repeated impression.

A well-functioning system satisfies

$$\mathcal{F}(X_{n+1}) \leq \mathcal{F}(X_n),$$

so that repeated printing preserves or improves structural fidelity. The fixed point is the configuration that reproduces itself invariantly across impressions.

The failure modes map cleanly onto the taxonomy of Section 10. Drift corresponds to type wear and progressive error accumulation. Rigidity corresponds to a plate that cannot be reset, producing the same output indefinitely even when it should be changed. Oscillation corresponds to inconsistent assembly of the form, producing alternating versions. Obstruction corresponds to missing types that prevent any admissible configuration from being realized.

The printing press is thus a technological realization of the Constraint–Recurrence Principle in its most literal form: it is a machine for achieving stability through constrained recurrence of material form.

## Semantic Compression and Memplex Structure

### Roots as Encoded Operators

The analysis of  $\text{أ ج ق}$  illustrates a more general point about the relationship between language and dynamical law. Certain lexical roots do not merely catalog the world; they encode processes that operate on the world. The root is a compressed operator: a symbolic representation of a transformation pattern that can be applied across a range of domains.

This connects to a broader theoretical claim developed in the author's work on the TARTAN and RSVP frameworks: that structured information systems — whether linguistic, cognitive, or physical — compress invariants into compact representations that can be deployed efficiently across contexts. A root like  $\text{أ ج ق}$  is an extreme case of this compression. A four-phoneme sequence encodes a dynamical schema that operates in reading, memory, ritual, physiology, and time.

### Ritual as Iterative Constraint Enforcement

Ritual more generally may be understood through this lens. A ritual form is a structured recurrence designed to enforce specific constraints on the participants and their relations. Repetition is not incidental to ritual; it is the mechanism by which constraint is enforced and by which the stability of the relevant configuration — social, cognitive, subjective — is maintained.

The Talbiya is a particularly clear case because its repetition is explicit and its constraint is stated. But the same structure appears in liturgical repetition across traditions, in the recitation of creeds, in the daily renewal of vows. In each case, the mechanism is the same: iterative application of a constrained recurrence converging the participants toward a fixed-point configuration.

### Media as Recurrence Infrastructure

Technologies of inscription and reproduction — writing, printing, recording, broadcasting — may be understood as infrastructure for recurrence. They extend the range over which a structure can be re-instantiated: from the bounded context of embodied utterance to the distributed context of a literate society, a printed edition, or a broadcast network.

Each such technology has its characteristic constraint structure. Writing en-

forces the constraint of alphabetic or logographic convention. Printing adds the constraint of typographic standardization. Recording adds the constraint of temporal fidelity. In each case, the technology is not merely a passive medium but an active constraint on what can be reproduced.

The consequence is that different media support different kinds of stability. An oral tradition can maintain a complex of meanings through mnemonic constraint and ritual repetition, but it is vulnerable to the failure modes of drift (variation under transmission) and obstruction (loss of the trained performers). A printed tradition is more resistant to drift but more vulnerable to rigidity (the fixed text resists revision) and to the particular failure modes of technological obsolescence.

## **Convergence Across Domains**

### **Why Similar Structures Reappear**

Having identified the same pattern in lexical semantics, ritual practice, and printing technology, it is natural to ask why. The answer is not that these traditions share a common origin. It is that they face a common problem, and the space of solutions to that problem is constrained in ways that make some solutions much more likely than others.

Any system that must maintain structure across time faces the following set of challenges. Time introduces variation; entropy tends to increase; the medium of transmission imposes noise; the agents of transmission are imperfect. A system that survives these pressures must somehow compensate: it must have mechanisms that detect and correct deviation, mechanisms that operate repeatedly rather than once, and mechanisms that specify what counts as deviation rather than merely providing a template.

These requirements correspond precisely to constraint and recurrence. Constraint specifies admissibility; recurrence provides the repeated enforcement; their composition produces the self-correcting dynamical loop that constitutes stability. Any system that achieves persistence does so by some implementation of this structure, even if the implementation takes very different material forms.

## **Against Naïve Etymological Unification**

The cross-domain comparisons in this essay should not be read as claims about shared linguistic history. The Arabic root **ق ر أ**, the structure of Qur'anic oaths, the Talbiya, and the Song dynasty printing press do not form a single lineage. They are independent realizations of a common structural pattern.

This distinction matters because it defines the scope of the claim. A genealogical claim would assert a historical link: this came from that, and that came from this. A structural claim asserts something more general and more interesting: independent systems have converged on the same solution because the solution space is constrained.

The latter claim is not diminished by the absence of historical connection. It is actually strengthened by it. If independent systems converge on the same pattern without any possibility of borrowing, the convergence cannot be explained by transmission; it must be explained by the structure of the problem. That explanation is more fundamental, not less.

## **Toward a General Theory of Structural Persistence**

The Constraint–Recurrence Principle provides the beginning of a general theory. It identifies the necessary conditions for persistence across a wide range of systems, characterizes stability as a fixed-point property, and provides a taxonomy of failure modes that applies uniformly across domains.

What it does not yet provide is a complete account of the conditions under which stable configurations emerge, of the relationship between constraint structure and the shape of the attractor landscape, or of the dynamics of transitions between stable configurations. These are open problems, and they point toward connections with renormalization theory, topological data analysis, and the physics of far-from-equilibrium systems that are developed in the broader research program to which this essay belongs.

## **Implications**

### **Epistemology: Truth as Stability Under Recurrence**

The analysis suggests a revisionary account of truth. On a correspondence theory, a proposition is true if it corresponds to how things are. On the account

developed here, a proposition is *stable* if it returns to itself under the normal operations of inquiry, revision, and testing. These are not the same. A proposition might correspond to how things are but be unstable under inquiry — fragile to new evidence, dependent on cognitive idiosyncrasy, unable to survive the recurrence of examination. A proposition that survives the constraint of evidence and the recurrence of scrutiny is robust in a sense that correspondence alone does not capture.

This is not a claim that truth reduces to stability. It is a claim that stability under constrained recurrence is the epistemological criterion by which truth-claims earn their standing.

### **Cognition: Memory as Reinstantiation**

Memory is typically described as storage and retrieval. The account developed here suggests a different model: memory as reinstatement under constraint. Recall is not the retrieval of a stored record; it is the reconstruction of a prior configuration under the constraint of what was previously known and the pressure of current context.

This model aligns with contemporary accounts in cognitive science of reconstructive memory and schema-guided recall. It also connects the theory of memory to the theory of linguistic meaning: both are recurrence processes governed by constraint, and both are subject to the same failure modes of drift (false memory), rigidity (perseveration), and oscillation (repetition compulsion).

### **Technology: Reproducibility as Persistence**

The analysis of printing suggests a criterion for evaluating technologies of inscription and reproduction: their capacity to maintain stability of structural form under iteration. A good technology of reproduction is one that implements an effective constraint operator and an effective recurrence mechanism — one that reliably reconstitutes the intended structure across a wide range of conditions.

This criterion applies to digital media as much as to movable type. The stability of digital text depends on the constraints of encoding standards, file formats, and error correction; its recurrence depends on the repeated re-instantiation of stored data in new contexts. The failure modes — corruption (drift), format lock-in (rigidity), version conflict (oscillation), data loss (obstruction) — are the

same as those identified in the printing case.

### **Artificial Intelligence: Alignment and Failure Modes**

The connection to artificial intelligence systems is direct. A language model that generates coherent text must implement something like a constraint on admissible output and a mechanism of recurrence across the sequence of tokens. When these conditions are not met, the characteristic failure modes appear.

Hallucination corresponds to recurrence without sufficient constraint: the model generates plausibly formed output that does not satisfy the constraint of factual correctness. Repetition corresponds to constraint without sufficient recurrence of new structure: the model is stuck at a local minimum. Inconsistency across a conversation corresponds to the oscillation failure mode: the model's effective configuration at different points in the conversation does not converge to a stable fixed point.

This analysis does not immediately solve the alignment problem, but it provides a vocabulary for characterizing it. A well-aligned system is one that achieves stable configurations under the relevant constraints — of honesty, helpfulness, and harmlessness — through the recurrence of constrained inference. The alignment problem is, in part, the problem of engineering effective constraint and recurrence.

### **Conclusion: Return Under Constraint**

#### **Restatement of the Principle**

The essay has developed and applied a single principle: that persistence is not a property of static objects but a dynamical achievement, arising when structure is repeatedly reconstituted under constraint. Formally, this is the condition that a system has a fixed point under the composite operator  $\mathcal{T} = \mathcal{R} \circ \mathcal{C}$ : a configuration that returns to itself when constraint is applied and the result is re-instantiated.

This principle is not arbitrary. It is the minimal condition that any system must satisfy if it is to maintain its identity across the disruptions of time, variation, and entropy. Systems that satisfy it persist; systems that do not drift, rigidify, oscillate, or dissolve.

## Unification of Examples

The three worked examples demonstrate the principle's operation across three very different material substrates.

The Arabic root  $\text{أ ر ق}$  shows that linguistic meaning can itself be a compressed form of this dynamical structure: the root encodes the schema of structured return in semantic form, instantiating it across the domains of language, memory, and time.

The Talbiya shows that the principle applies not only to objects and propositions but to subjects: persons are stabilized through iterative constrained recurrence, and their convictions are the fixed points of this process.

Movable type printing shows that the principle can be built into the physical substrate of a technology: the discrete types, the constraining frame, and the repeated impression realize the operator  $\mathcal{T}$  in material form.

Together, these examples demonstrate that the Constraint–Recurrence Principle is not an abstraction imposed on diverse phenomena but a genuine structural invariant that appears wherever persistence is achieved.

### A Physical Illustration: Rain on the Screen

A concrete physical analogy helps clarify why the limitation addressed by the Constraint–Recurrence Principle is structural rather than a defect of attention or design.

A capacitive touchscreen operates by detecting perturbations in an electrical field across its surface. Under normal conditions, these perturbations correspond to intentional contact. The device reconstructs a position and registers an input.

When rain falls on the screen, the droplets generate distributed perturbations that are indistinguishable, at the level of the sensing layer, from deliberate touch. The device registers simultaneous contacts across the surface despite the absence of any coherent action beneath them. It behaves erratically — not because its internal logic has failed, but because the projection from underlying state to observable signal does not preserve the distinction between intentional and environmental contact.

Formally, the sensing projection

$$\Pi_{\text{touch}} : X \rightarrow \mathcal{Y}_{\text{touch}}$$

is non-injective: distinct latent configurations (intentional gesture, falling water) produce similar observable patterns. The device applies a fixed interpretation rule to  $\mathcal{Y}_{\text{touch}}$  and is therefore structurally unable to recover the correct state.

No amount of sophistication at the interpretation layer resolves this. The limitation lies upstream, in the projection itself.

The Constraint–Recurrence Principle addresses the downstream question: given a system subject to this limitation, what conditions allow structure to persist anyway? The answer is that persistence does not require perfect interpretation. It requires only that the process of constrained recurrence be robust to the noise introduced by projection — that the composite operator  $\mathcal{T}$  converge even when individual observations are ambiguous.

In this sense, stability under constraint is the appropriate response to a world of partial projections. Not perfect reconstruction, but reliable return.

## Final Formulation

The conclusion of the essay may be stated as simply as possible.

What persists is that which returns under constraint.

This is not merely a formal condition but a characterization of what stability means in any domain. The stone that endures is not the paradigm of persistence. The paradigm is the flame, the text, the word, the conviction, the printed page: structures that persist not because they resist change but because they successfully return, under constraint, to themselves.

## Mathematical Details

### Banach Fixed-Point Theorem

The main convergence result (Theorem 8.4) follows directly from the classical Banach fixed-point theorem. Let  $(M, d)$  be a complete metric space and  $T : M \rightarrow M$  a contraction with constant  $k \in [0, 1)$ . Then  $T$  has a unique fixed point  $x^*$ , and

for any  $x_0 \in M$ , the sequence  $x_{n+1} = T(x_n)$  converges to  $x^*$  with error bound

$$d(x_n, x^*) \leq \frac{k^n}{1-k} d(x_1, x_0).$$

The entropy-based theorem (Theorem 8.7) follows from the monotone convergence of  $\mathcal{F}(X_n)$  and continuity of the operator. It is a variant of the descent lemma standard in optimization theory.

### Operator Properties

For the Constraint–Recurrence Principle to yield a well-defined fixed-point theory, the operators  $\mathcal{C}$  and  $\mathcal{R}$  must satisfy compatibility conditions. Most importantly, the image of  $\mathcal{C}$  must lie within the domain of  $\mathcal{R}$ , and the admissibility space  $\mathcal{A}$  must be closed under both operators.

In the linguistic case,  $\mathcal{A}$  is a semantic configuration space; in the ritual case, a subject-state space; in the technological case, a type-arrangement space. In each case, the relevant completeness and closure conditions are satisfied in the idealized model, with realistic deviations corresponding to the failure modes cataloged in Section 10.

### Convergence Conditions

The entropy-based formulation permits a more refined analysis of convergence conditions. If  $\mathcal{F}$  is strictly convex on  $\mathcal{A}$  and  $\mathcal{R}$  is a gradient step for  $\mathcal{F}$ , then convergence to the unique global minimum is guaranteed. In the absence of convexity, the sequence may converge to a local minimum (premature convergence) or to a limit cycle (oscillation).

The rate of convergence depends on the curvature of  $\mathcal{F}$  near the fixed point. In high-curvature regions (strong constraint), convergence is fast but the basin of attraction may be small. In low-curvature regions (weak constraint), convergence is slow but the basin of attraction may be large. This trade-off between speed and robustness is a general feature of constrained optimization.

## Linguistic Notes

### On the Root ق ر أ

The claim that the root ق ر أ encodes a unified dynamical schema should be understood as a structural hypothesis, not a historical etymology. Classical Arabic lexicography lists the meanings of the root under separate numbered entries, reflecting the normal conventions of lexicographic presentation. The structural interpretation is an additional layer of analysis, not a replacement for the philological record.

The specific claim about قُرْء and its dual interpretations is well-attested in Islamic jurisprudence; the standard references include the classical commentaries on Qur'an 2:228 and the relevant chapters of fiqh texts on family law. The dynamical interpretation of this duality as phase indexing on a cyclic manifold is the present author's theoretical contribution, not a claim found in the traditional sources.

### On Structural Comparison

The comparisons drawn in this essay between Arabic semantic structure, Qur'anic oath-formulas, the Talbiya, and printing technology are structural comparisons, not historical claims. No claim is made about shared linguistic origin, common cultural ancestry, or historical influence. The comparisons are justified by the identification of a common formal pattern.

This methodological stance follows the approach of structural linguistics, which identifies typological universals across languages without implying monogenesis. A typological universal is a pattern that appears in diverse languages because it reflects a general feature of language structure, not because all languages descend from a single ancestor. The present claims are analogous: the Constraint–Recurrence Principle is a structural universal of systems that must maintain identity across time.

## Extended Examples

### Reconstruction Systems and Constraint Closure

The Constraint–Recurrence Principle applies directly to artificial intelligence systems that perform reconstruction tasks: language models, vision systems,

and knowledge-base maintenance systems.

In each case, the system must reconstruct a coherent global configuration from partial and potentially inconsistent observations. The constraint operator enforces admissibility: the reconstructed configuration must be consistent with all observations and with background knowledge. The recurrence operator propagates the current reconstruction through the process of update and revision.

A system achieves stable reconstruction when its iterative process converges to a configuration that satisfies all constraints simultaneously. The failure modes are the same as those identified in earlier sections. Hallucination is recurrence without sufficient constraint. Repetitive output is constraint without sufficient recurrence of new structure. Inconsistency is oscillation between incompatible configurations. The absence of any consistent solution — when the constraints are jointly unsatisfiable — is obstruction.

The analysis suggests that the alignment problem in AI systems has a deep structural dimension: it is the problem of engineering systems whose constraint and recurrence operators are jointly effective, producing fixed points that satisfy the relevant admissibility conditions.

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