Simulation Synchronization Theory: A Feedback-Based Model of Affective Role Encoding and Social Identity Stabilization

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Abstract

This manuscript introduces Simulation Synchronization Theory (SST), a neurocognitively grounded model of interpersonal interaction in which individuals project affectively encoded role simulations into the social environment. These simulations—comprising identity expectations, behavioral templates, and emotionally weighted narratives—interact with external feedback through recursive loops that shape self-concept, perception, and behavior over time. SST posits that the self is not static, but emerges through the synchronization of internal simulations with social feedback. Affective intensity governs simulation persistence, while feedback valence modulates whether projected roles are confirmed, revised, or rejected. Identity stabilizes when simulation loops resolve through environmental alignment, internal reinterpretation, or distributed social confirmation.

To formalize this process, a symbolic loop model is introduced—{S(t), R(t), E(t), F(t), A(t)}—representing Simulation, Role, Environmental feedback, Feedback valence, and Affective weight. Drawing from affective neuroscience, predictive social cognition, and memory reconsolidation research, SST outlines structured observational cases and offers testable predictions across social behavior and identity dynamics. The manuscript is structured according to the Brisart Format, with sections detailing the core mechanism (2.0), internal processing dynamics (3.0), predictive applications (4.0), and future directions (5.0). SST provides a falsifiable, affectively modulated account of how internal representations become socially enacted realities.

1.0 Introduction

Understanding how internal representations translate into social identity, behavior, and interpersonal dynamics remains a key challenge in cognitive neuroscience. While existing models explain aspects of self-concept, role behavior, and social prediction, they often treat identity as a static construct or neglect the recursive nature of social feedback. This paper introduces Simulation Synchronization Theory (SST), a feedback-driven framework in which identity emerges from the synchronization of affectively encoded role simulations with social and environmental feedback.

The SST model proposes that individuals continuously generate internal simulations—mental representations of roles, interactions, and outcomes—that are encoded with affective salience and projected into the interpersonal environment. These simulations are not isolated thoughts, but structured models that bias perception, behavior, and expectation. Once projected, these simulations interact with the environment and other agents, triggering feedback loops that either reinforce, distort, or neutralize the original role.

In this framework, the self is not a fixed entity but a convergence point of recursive role encoding and environmental feedback. Affective intensity (E(t)) determines the persistence of a simulation; role stability (R(t)) is modulated by whether feedback confirms or contradicts the projected identity. When simulations receive confirming feedback, they stabilize into self-perception and identity-linked behavior. When feedback is absent, contradictory, or delayed, the simulation may escalate, diffuse, or invert—leading to conflict, misalignment, or role drift.

SST builds on findings from affective neuroscience, simulation theory, social cognition, and autobiographical memory. It formalizes the structure of recursive identity dynamics using symbolic loop variables and offers behavioral predictions and observational frameworks that can be tested in laboratory and real-world settings.

The following sections define the SST model formally, explore the neurocognitive underpinnings of role projection and synchronization, present empirical patterns, and outline testable predictions and future directions.

2.0 Core Mechanism

Simulation Synchronization Theory (SST) models consciousness and social identity as emergent properties of feedback-driven interactions between affectively encoded internal simulations and external social feedback. This section introduces the formal structure of SST using symbolic variables and defines how role dynamics evolve through recursive cycles of projection, feedback, and internal modulation.

2.1 Core Loop Components

The SST loop is defined by five interdependent variables:

- S(t) — Internal simulation state at time t, encompassing projected roles, behavioral expectations, and imagined outcomes.
- R(t) — Enacted or expressed role state (verbal, behavioral, nonverbal) emerging from the projected simulation.
- E(t) — Affective weighting of the simulation, including both valence and intensity; determines persistence and salience.
- F(t) — External feedback from the environment or others in response to R(t), interpreted by the agent as supportive, neutral, or disconfirming.
- A(t) — The agent's adaptive response—either reinforcing the simulation, modifying it, or suppressing it based on F(t).

These variables form a looped feedback process:

$S(t) \rightarrow R(t) \rightarrow F(t) \rightarrow A(t) \rightarrow S(t+1)$

with E(t) modulating the strength and persistence of the loop.

2.2 Simulation Persistence and Loop Reentry

Simulations with high affective salience ($E(t) >$ threshold) tend to persist in the loop and re-enter awareness or behavior unless resolved. This explains delayed identity enactment, intrusive thoughts, or recurrent behavioral patterns—especially in ambiguous or socially salient situations. The loop continues until:

- The simulation is enacted and receives confirming feedback
- Feedback matches the predicted role
- Affective intensity dissipates below the reentry threshold
- A more salient simulation replaces the original

2.3 Feedback-Driven Identity Convergence

Simulations that receive consistent confirmatory feedback are progressively internalized as self-concept. This convergence stabilizes identity-linked behaviors and cognitive narratives. Conversely, simulations repeatedly invalidated by feedback are modified, suppressed, or inverted.

2.4 Summary of Loop Dynamics

- Identity emerges from recursive synchronization of internal simulations and external feedback.
- Affective salience governs simulation persistence; feedback determines loop resolution or continuation.
- Identity stabilizes through alignment; destabilizes through contradiction or feedback delay.

The next section details the neurocognitive processes supporting each phase of this simulation-feedback loop.

3.0 Internal Processing Dynamics

The internal processing architecture of Simulation Synchronization Theory (SST) operates through recursive feedback loops shaped by affective encoding, memory-guided simulation, and social-environmental interactions. This section outlines how simulation states evolve over time, reenter cognitive focus, and stabilize or destabilize based on loop progression.

3.1 Affective Encoding and Salience Modulation

Emotionally salient content is more likely to be encoded, rehearsed, and reactivated (Dolcos et al., 2005; Phelps, 2006). In SST, this is formalized as $E(t)$, the affective intensity applied to a simulation. $E(t)$ determines whether a simulation becomes persistent, reemerges later, or fades without behavioral manifestation.

- Higher $E(t)$ increases simulation persistence and likelihood of feedback-seeking enactment.
- Salient simulations may reenter consciousness spontaneously in response to contextual cues or memory priming.

3.2 Hippocampal-Prefrontal Role Construction

The hippocampus retrieves autobiographical and contextual memory traces, while the prefrontal cortex integrates them with current social intentions. This enables:

- Retrieval of prior roles and behavioral templates ($S(t)$)
- Construction of role-based expectations ($R(t)$) based on environmental context
- Ongoing modulation via prediction and mismatch detection

3.3 Loop Continuity and Disruption

The feedback component $F(t)$ represents real-time social-environmental response. Feedback interpretation determines whether a simulation is:

- Confirmed and stabilized
- Rejected and modified
- Ignored and maintained unresolved

The adaptive component $A(t)$ encodes whether the agent reinforces, suppresses, or modifies the role simulation in preparation for future enactment. Over time, unresolved loops can either persist silently or distort perception and behavior.

3.4 Temporal Recurrence and Simulation Reentry

Loop cycles may span minutes, hours, or days depending on:

- The intensity of E(t)
- Contextual triggers matching prior S(t) content
- Absence of resolution via behavior or feedback

Simulations may re-enter through thought, impulse, or spontaneous behavioral initiation. SST thus accounts for non-linear time-course effects in identity enactment, internal conflict, and social rumination.

3.5 Summary of Processing Dynamics

- Identity-related simulations operate as recursive loops across internal and external domains.
- Loop stability depends on affective intensity, memory activation, and congruence with feedback.
- Simulations may reenter cognitive focus even after delay, leading to gradual behavioral convergence or inversion.

3.6 Alternate Topologies and Loop Configurations

While the canonical SST loop follows a recursive simulation-feedback-adaptation process, identity formation often follows nonlinear paths. These are formally outlined in Appendix B.

The next section explores real-world and empirical applications of SST and outlines testable predictions based on its loop structure.

4.0 Applications and Predictions

Simulation Synchronization Theory (SST) yields a broad spectrum of applications across psychology, neuroscience, behavioral science, and interpersonal communication. Its emphasis on recursive role encoding, feedback integration, and affective modulation offers a mechanistic basis for understanding identity formation, role conflict, delayed behavior, and observational learning.

This section presents a structured set of prediction-driven patterns grounded in SST's core loop dynamics. Each includes a theoretically anchored behavioral outcome, designed for empirical validation in laboratory, ecological, or longitudinal settings.

4.1 Delayed Role Enactment via Simulation Reentry

An individual imagines themselves confidently speaking during a seminar but takes no immediate action. Days later, during a discussion on a familiar topic, they unexpectedly contribute—without recalling the earlier simulation. The latent role ("I'm dependable and follow through") reactivates due to contextual familiarity and internal readiness.

Interpretation:

The simulation S(t), encoded with high affective salience E(t), remained latent until internal or environmental alignment enabled loop reentry and behavioral enactment.

Prediction:

High-E(t) simulations will manifest behaviorally over time—even in the absence of conscious recall—when environmental or internal conditions resemble the original encoding context.

Experimental validation:

This pattern can be tested using a delayed simulation activation paradigm in which participants encode identity simulations (e.g., “I will speak up”) reinforced by affective priming. Behavioral emergence is tracked over time using ecological momentary assessment (EMA) or context-matched laboratory prompts. It is predicted that high-E(t) simulations will spontaneously re-emerge when contextual or emotional resonance is reestablished.

4.2 Role Confirmation Through External Feedback

An individual internally anticipates that a question may make someone uncomfortable but says nothing. During the conversation, another person voices the same concern, triggering the expected reaction. The simulation resolves not through personal action, but via mirrored external feedback.

Interpretation:

The simulation loop closed observationally through external confirmation of an unexpressed role, reinforcing the projected identity.

Prediction:

Unexpressed simulations can resolve when external events align with internally encoded role expectations, even without personal enactment.

Experimental validation:

This pattern can be tested using an observational confirmation paradigm in which participants internally encode role expectations (e.g., anticipating a social outcome) and then participate in a structured group interaction. In select conditions, confederates express the predicted behavior or concern. Post-task measures—such as self-report, identity salience ratings, and behavioral alignment in follow-up scenarios—can assess whether loop closure occurs and whether the encoded identity simulation is reinforced despite passive observation.

4.3 Role Stabilization Through Repetition and Feedback Alignment

An individual repeatedly affirms the role “I am always late,” and receives consistent social feedback—jokes, comments, or criticism—that reinforces it. Over time, they begin to embody the role habitually, even without conscious intent. Identity stabilizes through repeated simulation-feedback alignment.

Interpretation:

Behavioral convergence occurs when a simulation is reinforced by consistent external feedback. Loop repetition strengthens E(t), embedding the role into self-concept.

Prediction:

The more consistent and affectively salient the feedback to a repeated simulation, the more likely it is to stabilize as a persistent identity-linked behavior.

Experimental validation:

This pattern can be tested using a role reinforcement paradigm in which participants repeatedly self-affirm an identity statement (e.g., “I am always late”) over multiple sessions. In aligned conditions, confederates or scripted feedback consistently reflect and reinforce the stated identity. Over time, measures such as behavioral tracking, self-report identity scales, and simulation salience probes can assess whether role stabilization occurs, and whether feedback alignment modulates E(t) strengthening and behavioral entrenchment.

4.4 Role Inversion and Loop Destabilization

An individual mentally projects themselves as helpful, but receives subtle social dismissal. Over time, they withdraw and adopt a new internal narrative: “I’m too much.” The original role destabilizes and inverts due to persistent disconfirmation.

Interpretation:

When a simulation fails to receive confirming feedback, the loop destabilizes. If E(t) remains high, disconfirmation can trigger identity reversal or fragmentation.

Prediction:

Simulations exposed to repeated disconfirmation are likely to invert or fragment, especially when affective salience E(t) is sustained.

Experimental validation:

This pattern can be tested using a loop disconfirmation paradigm in which participants encode a positively valenced identity simulation (e.g., “I am helpful”) and engage in repeated social tasks. In some conditions, subtle negative feedback or social dismissal is introduced over time. Identity salience, emotional response, and simulation persistence are measured longitudinally through self-report, behavioral coding, and physiological markers. It is predicted that high-E(t) simulations, when persistently disconfirmed, will show signs of inversion or destabilization—reflected in shifts in self-perception, reduced enactment, or emergence of compensatory narratives.

4.5 Observational Closure and Distributed Resolution

An individual mentally rehearses standing up to a rude co-worker but never takes action. Later, they observe another colleague assertively addressing similar behavior. The individual feels relieved and begins acting more assertively in future situations. The internal simulation resolves not through direct enactment, but via third-party behavioral mirroring.

Interpretation:

The simulation loop closed observationally through distributed feedback. Affective tension discharged without direct role performance, indicating simulation resolution can occur via proxy enactment.

Prediction:

Latent simulations can resolve and influence future behavior when observed external events mirror the internally encoded role—even in the absence of personal action or direct feedback.

Experimental validation:

This pattern can be tested using a proxy resolution paradigm. Participants encode an identity simulation (e.g., “I will speak up”) and are placed in observational conditions where a confederate enacts the simulated role in a relatable context. Pre- and post-observation measures assess emotional relief, identity salience, and behavioral change. It is predicted that participants in the proxy resolution condition will demonstrate reduced simulation tension and increased likelihood of enacting related roles in future scenarios.

4.6 Contextual Resonance and Implicit Simulation Triggers

An individual thinks about updating a journaling app but doesn't act. Days later, in a similar emotional state, they feel a sudden urge to write—without recalling the earlier intention. The original simulation reactivates through contextual-affective similarity rather than explicit memory.

Interpretation:

The simulation S(t) remained latent due to inaction. Reentry was triggered by affective resonance between the current and original internal states, bypassing conscious recall.

Prediction:

Latent simulations with unresolved E(t) can reenter active processing when emotional or environmental conditions mirror their original encoding context, even without direct cues or memory retrieval.

Experimental validation:

This dynamic can be tested using a context-triggered reentry paradigm. Participants encode a goal-oriented identity simulation (e.g., "I should journal tonight") during a specific affective priming session. Days later, they are exposed to either a matched or mismatched emotional context. Behavioral initiation (e.g., journaling), self-reports of intention recall, and physiological markers of arousal are assessed. It is predicted that matched emotional contexts will increase the likelihood of spontaneous simulation reentry and action—even when the participant does not consciously remember the original simulation.

4.7 Loop Fragmentation and Identity Instability

An individual in a new job projects a competent, proactive role but receives little acknowledgment or feedback. Over time, they fluctuate between feeling empowered and insecure, exhibiting inconsistent behavior and a fragmented self-concept. The simulation fails to stabilize, trapped in ambiguity and unresolved tension.

Interpretation:

When feedback F(t) is inconsistent, ambiguous, or absent, the SST loop cannot converge. High-E(t) simulations remain unresolved, resulting in identity oscillation and internal conflict.

Prediction:

In the absence of clear feedback, individuals with high-E(t) simulations will display unstable role enactment and fluctuating self-perception due to failed loop resolution.

Experimental validation:

This pattern can be tested using a feedback ambiguity paradigm. Participants adopt a simulated role (e.g., "I am competent") and complete tasks under varying feedback conditions: consistent, ambiguous, or absent. Behavioral consistency, identity confidence ratings, and emotional volatility are tracked across trials. It is predicted that participants in the ambiguous/absent feedback conditions will show greater role instability and self-concept fluctuation—especially when initial simulations are affectively salient.

5.0 Limitations and Future Work

While Simulation Synchronization Theory (SST) offers a novel, empirically testable model of identity formation through affectively modulated role-feedback loops, it presently operates at a mid-level of abstraction. The following limitations and future directions aim to strengthen its empirical grounding, methodological precision, and interdisciplinary relevance.

5.1 Neural Resolution and Mechanistic Specificity

SST integrates well-established neural principles—including hippocampal-prefrontal interaction, salience-based encoding, and internal simulation dynamics—but currently lacks fine-grained anatomical and temporal resolution.

Future work should:

- Employ time-resolved neuroimaging techniques (e.g., magnetoencephalography, intracranial EEG, high-temporal-resolution fMRI) to track loop persistence and simulation resolution in real time.
- Investigate how variation in affective salience (E[t]) influences neural replay and behavioral emergence trajectories.
- Determine whether distinct neural pathways underlie different role types, such as adaptive versus defensive simulations.

5.2 Quantifying Internal Simulations

A key empirical challenge involves detecting high-E(t) internal simulations that remain unexpressed yet continue to shape behavior and identity.

Potential strategies include:

- Implementing ecological momentary assessment (EMA) to record simulation content and context in situ.
- Using physiological proxies (e.g., heart rate variability, galvanic skin response, pupil dilation) to detect loop activation or unresolved affective tension.
- Training machine learning classifiers on neuroimaging data to infer simulation content, duration, and emotional weighting.

5.3 Experimental Paradigms for Loop Testing

SST yields precise behavioral predictions derived from loop dynamics and feedback interactions, offering multiple avenues for empirical testing.

Suggested paradigms include:

- Role Priming Tasks: Participants encode identity statements (e.g., "I am competent") and receive congruent or incongruent social feedback.
- Feedback Mismatch Studies: Evaluate whether simulations persist, invert, or fragment in response to unexpected or ambiguous feedback.
- Distributed Resolution Conditions: Test whether observing third-party enactment of a simulated role can trigger loop closure and affect behavioral outcomes.

(See Appendix A for full experimental details.)

5.4 Ethical Considerations

Given the emotional salience of identity-related simulations, ethical safeguards are essential—particularly when inducing unresolved, destabilized, or disconfirmed roles.

Recommended precautions:

- Prioritize neutral or affirming role simulations in study design.
- Fully debrief participants following exposure to ambiguous or disconfirming feedback.
- Avoid repeated induction of distressing or unresolved identity simulations, especially in vulnerable populations.

5.5 Framework Integration and Broader Relevance

SST is not intended as a totalizing model of consciousness or personality but rather as a mid-level framework that complements existing theories in cognitive science, affective neuroscience, and social psychology.

Promising directions for expansion include:

- Exploring SST dynamics during altered states of consciousness (e.g., dreaming, psychedelic experience, dissociation).
- Investigating whether activity in the default mode network or salience network predicts simulation reentry, fragmentation, or resolution.
- Applying SST principles to group identity dynamics in institutional, cultural, and digital contexts.

5.6 Summary

SST conceptualizes identity as an emergent product of recursive simulation-feedback loops modulated by affective salience. To further refine its theoretical scope and empirical robustness, future research should deepen its neural specificity, develop tools for tracking latent simulation states, and validate its predictions across experimental and ecological settings. These advancements will position SST as a foundational framework within the evolving landscape of identity science and cognitive theory.

Unlike static or declarative models of selfhood, SST proposes that identity is fluid—stabilizing only when feedback loops align with internal simulation dynamics. Through this lens, self-concept is not merely discovered, but enacted, shaped, and sustained through recursive social interaction.

5.7 Symbolic Recap

The core symbolic model—{S(t), R(t), E(t), F(t), A(t)}—offers a formal structure for examining how projected simulations (S) become enacted roles (R), modulated by affective salience (E), and shaped by feedback (F), resulting in adaptive change (A). This loop captures both conscious and latent simulation dynamics, enabling precise predictions and cross-domain applications. Persistent, high-affect simulations stabilize identity when validated externally or reinterpreted internally; when disconfirmed or unresolved, they fragment or remain latent, guiding behavior subconsciously.

6.0 Final Synthesis

Simulation Synchronization Theory provides a neurocognitive model of selfhood that is both empirically testable and symbolically formalized. As methods for decoding internal simulations advance—from affective computing to real-time neural decoding—SST may serve as a unifying framework for understanding how identity is constructed, disrupted, and stabilized through social resonance. It reframes identity not as a fixed trait, but as a dynamic outcome of recursive interactions between internal intent and external validation. In doing so, it offers a new lens through which to study the self—not as a noun, but as a verb in perpetual negotiation.

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Appendix A: Experimental Paradigms for Testing Simulation Synchronization Theory

This appendix outlines proposed experimental paradigms designed to test the predictions and mechanisms of Simulation Synchronization Theory (SST). Each paradigm targets a specific aspect of the SST loop: simulation encoding, affective modulation, role projection, feedback alignment, or loop resolution. The goal is to empirically validate key components of the model and identify measurable behavioral and neural correlates.

A.1. Role Priming and Feedback Validation Task

Objective: To examine how affectively encoded role simulations are reinforced, modified, or suppressed based on social feedback.

Procedure:

- Participants are presented with identity statements (e.g., “I am confident,” “I am burdensome”) and asked to silently affirm or reject them.
- These statements are affectively weighted using priming techniques (e.g., background music, imagery, or autobiographical memory recall).
- Participants then engage in a live or simulated social interaction (e.g., chat with a confederate or virtual avatar).
- Feedback is manipulated to either align with, contradict, or ignore the primed identity.

Predictions:

- Confirmatory feedback increases the persistence and behavioral enactment of the simulation.
- Contradictory feedback triggers loop destabilization or role inversion.
- Affective salience ($E(t)$) modulates simulation persistence independent of explicit feedback.

A.2. Observational Closure Paradigm

Objective: To test whether simulations can be resolved or reinforced without direct behavioral expression, via affectively congruent external observation.

Procedure:

- Participants encode a simulation internally (e.g., "I am protective") and are instructed not to act on it.
- Later, they observe a scene (video or staged event) that either aligns or misaligns with the encoded role.
- Emotional and cognitive resonance is measured via self-report and physiological markers (e.g., heart rate variability, pupil dilation).

Predictions:

- Role-aligned observation will reduce simulation reentry and trigger emotional closure.
- Misaligned observation will prolong internal simulation activity or produce emotional dissonance.

A.3. Simulation Reentry and Time-Delay Task

Objective: To measure how long simulations persist and whether they spontaneously re-emerge in behavior under matched context.

Procedure:

- Participants generate a list of personal goals or identity claims (e.g., "I want to speak up more"), encoded with emotional reinforcement.
- After a delay (ranging from hours to days), they encounter opportunities to act in alignment with their simulation in a naturalistic or lab setting.
- Spontaneous enactment is measured without prompting.

Predictions:

- Simulations with high $E(t)$ are more likely to re-emerge spontaneously.
- Contextual similarity (e.g., similar emotional environment) increases reentry likelihood.

A.4. Feedback Mismatch and Loop Destabilization Paradigm

Objective: To explore the effects of feedback dissonance on simulation persistence and role inversion.

Procedure:

- Participants are instructed to enact a projected role (e.g., "leader," "listener") in a group setting.
- Feedback is covertly manipulated through confederates or scripted reactions that subtly contradict the participant's projected role.
- Follow-up interviews and behavior tracking assess internal reinterpretation, suppression, or inversion of the original role.

Predictions:

- High $E(t)$ simulations resist suppression and show inversion effects if feedback is persistently disconfirming.
- Participants with lower affective salience may disengage from the role entirely.

A.5. Physiological Loop Tracking with Wearables

Objective: To assess whether internal simulation reentry correlates with physiological signals in real time.

Procedure:

- Participants wear biometric sensors (e.g., skin conductance, heart rate monitors) throughout the day.
- They also log internal simulations and emotional states via an app interface.
- Data are analyzed to detect patterns of simulation persistence, resolution, and reactivation based on environmental triggers.

Predictions:

- Persistent simulations correlate with measurable physiological arousal.
- Feedback-aligned events produce detectable affective shifts and simulation resolution markers.

Appendix B: Alternate Loop Topologies

While the canonical SST loop is linear and recursive—flowing from simulation (S) through role enactment (R), affective weighting (E), feedback (F), and adaptive response (A)—real-world identity dynamics often exhibit alternate loop configurations. These topologies reflect variations in feedback delay, simulation layering, observational convergence, and cross-agent entanglement.

B.1. Delayed Feedback Loop

Description:

In cases where feedback is temporally delayed (e.g., online communication, asynchronous interaction), simulation persistence may increase. Without immediate environmental input, the loop sustains internally, often escalating or fragmenting based on unresolved affect.

Structure:

$S(t) \rightarrow R(t) \rightarrow$ [Feedback Delay] $\rightarrow F(t + \Delta) \rightarrow A(t + \Delta) \rightarrow S(t + \Delta + 1)$

Implication:

- Increases risk of identity distortion or projection
- May lead to higher reliance on imagined feedback or affectively biased interpretation
- Common in long-distance relationships, social media interactions, and unresolved interpersonal conflict

B.2. Simulation Stacking and Layered Roles

Description:

Individuals may hold and project multiple overlapping simulations at once, especially in complex or high-stakes situations. These are stacked simulations, each with distinct affective charges and feedback trajectories.

Structure:

$S_1(t), S_2(t), \ldots, S_n(t) \rightarrow R_1(t), R_2(t), \ldots, R_n(t) \rightarrow F_{1\ldots n}(t) \rightarrow A_{1\ldots n}(t) \rightarrow S_{1\ldots n}(t+1)$

Implication:

- Enables simultaneous role navigation (e.g., professional, relational, performative)
- Conflicting simulations may interfere with loop closure
- Affective priority ($E_1 > E_2 > \ldots$) often dictates dominant expression

B.3. Observational Loop Closure

Description:

A simulation may resolve not through direct feedback to the agent, but by witnessing a parallel or symbolic resolution externally—such as through media, fiction, or observing others.

Structure:

$S(t) \rightarrow$ [No direct R] $\rightarrow$ [Observed F*] $\rightarrow A(t^*) \rightarrow S(t+1)$

Implication:

- Allows passive resolution of affective content
- Explains emotional impact of stories, films, and symbolic encounters
- Reinforces concept of "distributed closure" where loops resolve without active enactment

B.4. Social Loop Entanglement

Description:

In tightly bonded relationships (e.g., romantic partners, codependents, or enmeshed group identities), one agent's loop can embed into another's, causing interdependent simulation-feedback cycles.

Structure:

$S_1(t) \rightarrow R_1(t) \rightarrow F_2(t) \rightarrow A_1(t) \rightarrow S_1(t+1)$

$S_2(t) \rightarrow R_2(t) \rightarrow F_1(t) \rightarrow A_2(t) \rightarrow S_2(t+1)$

Implication:

- Identity changes become mutually dependent
- Feedback meant for one role may be misinterpreted as relevant to both
- Explains "identity fusion," empathetic entanglement, or mirrored emotional reactivity

B.5. Inverted Loop Topology

Description:

In some cases, identity change begins with an external cue that triggers retroactive simulation alignment—reversing the typical forward flow.

Structure:

$F(t) \rightarrow A(t) \rightarrow S(t) \rightarrow R(t)$

Implication:

- Seen in trauma reprocessing or sudden self-awareness after external shock
- Challenges assumption that simulations always precede role enactment
- Useful for modeling post-event reinterpretation or rapid internal shifts

B.6. Summary

These alternate topologies highlight the flexibility of SST's simulation-feedback architecture. By accommodating delay, multiplicity, external observation, interpersonal entanglement, and reverse flow, SST can explain a broader range of identity phenomena—bridging theoretical precision with ecological realism. These configurations can be formally modeled or tested using time-resolved behavioral and neural data.

Appendix C: Experimental Paradigm Templates for SST Validation

To support empirical testing of Simulation Synchronization Theory (SST), this appendix outlines several experimental paradigm templates. These templates are designed to operationalize core SST variables—simulation (S), role enactment (R), affective salience (E), feedback (F), and adaptive response (A)—in controlled settings. Each paradigm targets a different aspect of the loop mechanism and provides methodological guidance for future studies.

C.1. Role Priming and Feedback Congruence Task

Objective:

Examine how affectively encoded identity simulations influence behavior, and how external feedback modulates simulation persistence or modification.

Design:

1. Participants are primed with identity-related statements (e.g., "You are assertive" or "You are shy"), each tagged with emotionally positive, neutral, or negative phrasing.
2. After a delay, participants engage in a social interaction or decision-making task.
3. Feedback is manipulated (confirming, disconfirming, or ambiguous).
4. Follow-up measures assess behavior change, emotional state, and self-perception.

Variables:

- S(t): Identity prime
- E(t): Affective tone of the prime
- R(t): Behavior in social task
- F(t): Feedback condition
- A(t): Post-task identity self-rating and emotional adjustment

Predictions:

- Positive, high-E(t) simulations should persist despite ambiguous feedback.
- Repeated disconfirmation should destabilize the simulation unless affect is strong.

C.2. Simulation-Triggered Behavioral Delay Task

Objective:

Test SST's prediction that affectively salient simulations can trigger delayed behavior activation even after the simulation leaves conscious awareness.

Design:

1. Participants are asked to vividly imagine a specific behavior (e.g., helping someone, apologizing, confronting a peer), with varying emotional intensities.
2. No immediate action is taken.
3. Over several days, participants are observed (or report via EMA) to assess if and when the simulated behavior is enacted.

Variables:

- S(t): Simulation at encoding
- E(t): Rated emotional charge
- Delay Duration: Time to enactment
- Loop Outcome: Confirmation, suppression, or reentry

Predictions:

- High-E(t) simulations will re-emerge as behavior even after time delay.
- Weakly encoded simulations will decay unless externally reinforced.

C.3. Observational Resolution Paradigm

Objective:

Validate SST's claim that simulations can resolve through observed external events that match their structure or emotional tone.

Design:

1. Participants internally simulate a specific social outcome without enacting it.
2. Later, they observe a video, narrative, or social scenario where that outcome is displayed by others.
3. Changes in affect, arousal, and narrative closure are measured.

Variables:

- S(t): Internal simulation
- F(t): Observed external match
- A(t): Emotional closure, relief, or update in self-concept

Predictions:

- Congruent observed outcomes lead to reduction in simulation-related arousal or rumination.
- Incongruent observations prolong or destabilize the loop.

C.4. Feedback Reversal and Loop Inversion Study

Objective:

Test loop inversion dynamics: when feedback contradicts simulation expectations, triggering role reversal or suppression.

Design:

1. Participants simulate a confident, proactive behavior.
2. During enactment, they receive dismissive or contradictory feedback.
3. Post-interaction ratings of self-view, confidence, and behavioral intent are collected.

Variables:

- S(t): Confidence simulation
- F(t): Dismissive feedback
- A(t): Withdrawal or inverted behavior
- R(t+1): Modified enactment

Predictions:

- Repeated invalidation of high-E(t) simulations will trigger role inversion.
- Individuals with higher trait emotional resilience may resist inversion.

C.5. Summary

These paradigms operationalize key predictions of SST and enable rigorous testing across behavioral, affective, and neural domains. They can be adapted for fMRI, EEG, or physiological tracking, and integrated with longitudinal or ecological designs. By formalizing testable predictions and linking them to structured tasks, SST can move from conceptual model to empirically validated framework—facilitating interdisciplinary adoption and refinement.

Appendix D: Experimental Paradigm Matrix

This appendix outlines potential experimental designs for testing core mechanisms and predictions of Simulation Synchronization Theory (SST). Each paradigm targets a specific loop dynamic (e.g., simulation persistence, role inversion, observational closure) and is mapped to the relevant symbolic components and behavioral metrics.

D.1. Role Priming and Feedback Resolution Task

Purpose: To test the stability and resolution of affectively charged simulations in the presence of aligned or misaligned feedback.

Method:

- Participants are primed with identity statements (e.g., “I am competent,” “I am unreliable”) and asked to imagine acting from that identity.
- They are then placed in simulated social scenarios where feedback either confirms, ignores, or contradicts the projected identity.
  Metrics:
- Changes in self-report identity salience
- Behavioral expression of the primed role
- Persistence or inversion of simulation content over time
  Mapped Variables: S(t), E(t), F(t), A(t)

D.2. Latent Simulation Activation via Contextual Cues

Purpose: To investigate whether previously encoded, unresolved simulations re-enter behavior or cognition in contextually matched settings.

Method:

- Participants encode a simulation (e.g., planning to be assertive in a future meeting), which is then left unexpressed.
- Days later, they are unknowingly exposed to environments or cues that match the initial simulation context.
  Metrics:
- Behavioral congruence with prior simulation
- Affective and physiological reactivity
- Recall accuracy of the original encoding event
  Mapped Variables: S(t), E(t), Delay Duration, Loop Outcome

D.3. Distributed Resolution Through Observational Congruence

Purpose: To test whether simulations can resolve when external events mimic the projected role, without direct enactment.

Method:

- Participants generate private role simulations (e.g., "I might be perceived as controlling") and are later exposed to third-party interactions that mirror the projected dynamic.
  Metrics:
- Affective alignment with observed role resolution
- Post-event identity shifts
- Comparison to control group with no observational match
  Mapped Variables: S(t), F(t), A(t), Simulation Outcome

D.4. Feedback Mismatch and Loop Inversion Task

Purpose: To observe how repeated feedback contradiction alters simulation content and behavioral expression.

Method:

- Participants enact roles (e.g., supportive, enthusiastic) in group tasks. Feedback is systematically structured to be dismissive or contradictory.
- Post-task identity statements are collected.
  Metrics:
- Role reversal or suppression
- Increased simulation fragmentation or loop escalation
- Affective reappraisal measures
  Mapped Variables: R(t), F(t), A(t), Loop Outcome

D.5. Simulation Reentry and Delay-Linked Activation

Purpose: To examine the time lag between encoding and enactment of affectively loaded simulations.

Method:

- Participants encode identity simulations during an emotional or meaningful moment (e.g., after viewing inspiring content).

- Follow-up assessments test whether the role is later enacted in unrelated contexts.
  Metrics:
- Delay duration
- Affective valence at reentry
- Correspondence to original role structure
  Mapped Variables: S(t), E(t), Delay Duration, R(t)

D.6. Summary Table of Paradigms

Paradigm	**Core Variables**	**Behavioral Metrics**	**Experimental Target**
Role Priming	S, E, F, A	Role behavior, affect, resolution	Feedback congruence
Contextual Reactivation	S, E, Delay	Spontaneous action, recall	Latent loop reentry
Observational Closure	S, F, A	Affective shift, identity integration	Distributed resolution
Feedback Mismatch	R, F, A	Loop inversion, emotional conflict	Disconfirming loops
Delay Activation	S, E, Delay, R	Time-linked enactment	Simulation persistence

These paradigms can be refined and extended based on the specific hypotheses of future SST-related research programs.