Core Research Questions

Version: 2.0
Date: 2026-06-06
Status: Expanded — Integrates CoreQuestions_vNext.md, SRT v0.2, OpenProblems v1.0, HANDOVER priorities

> Questions are organized by level of abstraction.
> Higher levels represent meta-questions about lower levels.
> Each level is linked to its connected hypotheses (H1–H10) and open problems (OP-01–OP-09).
> **No question below is resolved. These are organizing frameworks for investigation, not answers.**

Program-Level Central Question

> **How do humans come to see something new?**

This question frames the entire research program at its highest level of abstraction.
It subsumes the theory-level central question:

> **How do humans detect explanatory significance?**

Both questions remain open. The second is the current operational focus of Paper 4.

The Question Hierarchy

The questions form a layered structure from empirical observation (Level 0) through structure and discovery (Levels 1–2), significance and questions (Levels 3–4), explanation (Level 5), and concept evolution (Levels 6–8).

Each level asks a different kind of "why" — the levels do not merely add detail; they shift the type of question being asked.

Level 0 — Observation

What empirical phenomena require explanation?

These are the ground-level observations that started the research program.
They are factual starting points, not questions about psychology or cognition.

- **Q0.1** Why do XOR/XNOR Boolean functions produce checkerboard patterns in Karnaugh maps?
- **Q0.2** Why do symmetric Boolean functions generate recurring visual forms (ring, corner, point) in K-map representations?

- **Q0.3** Why does variable rearrangement produce visually distinct K-maps for the same logical function?
- **Q0.4** What structural properties of a Boolean function survive all 24 variable arrangements?

Primary case studies: Papers 1, 2, 3
Connected hypotheses: H2 (representation reveals structure)
Note: Level 0 questions have candidate answers in the empirical papers. They serve as the foundation that motivates all higher-level questions.

Level 1 — Structure

How do patterns become structures in human perception?

Level 0 describes what happens in mathematics. Level 1 asks what happens in the observer.

- **Q1.1** Why do humans recognize these patterns as **structures** rather than noise or coincidence?
- **Q1.2** What distinguishes a **pattern** from a **structure** in human perception?
- **Q1.3** Why is the checkerboard recognized as a single unified whole rather than a cell-by-cell aggregate?
- **Q1.4** Does structure recognition require prior conceptual knowledge, or can it operate without it?
- **Q1.5** Is structure recognition a perceptual act, a cognitive act, or both?

Connected hypotheses: H1 (structure discoverer), H2 (representation transformation)
Connected open problems: OP-01 (attention selection), OP-04 (representation design)
Relation to Level 0: Level 1 does not ask why the pattern exists (Level 0), but why humans notice and name it as a structure.

Level 2 — Discovery

Why do humans discover particular structures at particular times?

Level 1 asks how patterns become structures. Level 2 asks why some structures are discovered and others are not.

- **Q2.1** Why do humans discover particular structures and not others of equivalent visual complexity?
- **Q2.2** What determines which structures attract sustained investigative attention?
- **Q2.3** Is structure discovery a deliberate act of search, or a spontaneous recognition?
- **Q2.4** What role does prior conceptual knowledge play in enabling structure discovery?
- **Q2.5** If AI and a human examine the same Karnaugh map, do they discover the same structures?

Connected hypotheses: H1 (structure discoverer), H3 (attention filter)
Connected open problems: OP-01 (attention selection), OP-06 (AI structure discovery)
Relation to Level 1: Level 2 is not asking how patterns become structures, but why particular structures are selected for sustained attention.

Level 3 — Significance

Why do certain structures feel important?

Level 2 asks which structures attract attention. Level 3 asks why some attended structures feel worth investigating.

- **Q3.1** Why do certain structures feel **important** while others of equal clarity do not?
- **Q3.2** What are the operative criteria of the significance filter (H4)?
- **Q3.3** Is invariance under transformation a universal significance criterion, or is it domain-specific?
- **Q3.4** Does the significance judgment operate consciously, pre-reflectively, or both?
- **Q3.5** Can the significance filter be made explicit and taught as a skill?
- **Q3.6** Does the significance filter differ across researchers, or are there shared criteria?

Connected hypotheses: H4 (significance filter), H6 (explanatory significance), H7 (mature structure discoverer)
Connected open problems: OP-02 (significance boundary), OP-05 (invariance significance)
Relation to Level 2: Attention (Level 2) is a prior selection; significance (Level 3) is a further evaluation. A structure can attract attention without being deemed research-worthy.

Level 4 — Question Generation

How do structures become research questions?

Not all significant structures generate research questions. Level 4 asks about the transition from significance judgment to question formation.

- **Q4.1** Why do certain structures develop into research questions while others do not?
- **Q4.2** What distinguishes a structure that generates curiosity from one that does not?
- **Q4.3** Is research question generation a skill that can be trained and improved?
- **Q4.4** Does the research question originate in the structure, in the observer, or in their interaction?
- **Q4.5** What is the role of conceptual vocabulary in making a question formulable?
- **Q4.6** Can a question only be formed after the right concept is available?

Connected hypotheses: H4, H6, H7
Connected open problems: OP-02 (significance boundary), OP-08 (research question origin)
Relation to Level 3: A structure can be judged significant without yet crossing the research threshold, and so without generating a specific research question. Question generation requires not just judgment of significance, but the formation of a specific inquiry.

Level 5 — Explanation

How do humans orient toward explanation before finding it?

Level 4 describes question formation. Level 5 asks about the anticipatory structure of the inquiry — the sense that an explanation exists before it is found.

- **Q5.1** How do humans detect **explanatory significance** — the sense that a structure should have a structural explanation?
- **Q5.2** Do humans anticipate the existence of an explanation before they discover it?
- **Q5.3** What triggers the sense that "there must be a reason for this"?
- **Q5.4** Is explanation anticipation a separate cognitive act from structure recognition?
- **Q5.5** Can explanation anticipation occur without any prior theory about the domain?
- **Q5.6** Is explanation anticipation necessary for research initiation, or merely facilitative?

Connected hypotheses: H5 (explanation anticipation), H6 (explanatory significance)
Connected open problems: OP-03 (explanation anticipation mechanism)
Relation to Level 4: Question generation (Level 4) describes what the question is. Level 5 describes the motivational orientation — the felt sense that the structure demands an explanation — that drives the inquiry.

Level 6 — Concept

How does the formation of new concepts change what can be observed?

(Level 6–8 from CoreQuestions_vNext.md, integrated with SRT v0.2 H8–H10)

The levels above address what happens when a human encounters a phenomenon.
Levels 6–8 address how **the existence of a concept** changes what can be encountered in the first place.

- **Q6.1** What makes a concept effective as an observation lens (H8)?
- **Q6.2** Are concepts discovered or invented?
- **Q6.3** Why do some concepts generate new research programs while others remain merely descriptive?
- **Q6.4** Can a concept be deliberately designed to maximize its structure-revealing power?
- **Q6.5** Is the visibility-enhancing power of a concept (H8) measurable?

Connected hypotheses: H8 (concept as lens), H10 (generative concept)
Connected open problems: OP-07 (concept-as-lens)
Relation to Level 5: Levels 0–5 describe the processing of a single encounter with a phenomenon. Level 6 asks how having certain concepts changes what encounters are possible.

Level 7 — Expanded Perception

How does concept acquisition change what is visible?

Level 6 asks about the concept as a lens. Level 7 asks about the change in perception that results from acquiring the lens.

- **Q7.1** How do concepts change what a researcher can observe?
- **Q7.2** Why do some concepts reveal previously invisible structures?
- **Q7.3** Can new observations be produced by conceptual change alone, without new data or new instruments?

- **Q7.4** What is the relationship between conceptual change and observation change — do they always co-occur, or can one precede the other?
- **Q7.5** Is there a limit to how much a single concept can expand perception?

Connected hypotheses: H8 (concept as lens), H9 (concept evolution)
Connected open problems: OP-07 (concept-as-lens)
Evidence from this program: The concept of "structural invariance" made the question "what properties survive transformation?" formulable — a question that was not available before the concept existed.

Level 8 — New Discovery

How does the concept evolution cycle generate new discovery cycles?

Level 7 describes the change in perception due to a concept. Level 8 asks about the systemic dynamics — how a concept, by enabling new perception, generates new research, which generates new concepts.

- **Q8.1** What causes a research field or program to expand over time?
- **Q8.2** How do concepts generate further concepts through expanded perception?
- **Q8.3** Can the Concept Evolution Cycle (H9) be modeled formally?
- **Q8.4** Can the cycle be used deliberately — can a researcher accelerate their own discovery cycle?
- **Q8.5** Are there structural conditions under which the concept evolution cycle stalls or terminates?

Connected hypotheses: H9 (concept evolution), H10 (generative concept)
Evidence from this program: Pattern → Layer Structure → Equivalence → Structural Invariance → Structure Recognition Theory → Human-AI Collaboration Model. Each concept made the next visible.

Full Question Inventory

Questions are grouped by type and cross-referenced to hypotheses and open problems. The "Level 1–3" labels on the three groups below number these inventory groups; they are not the Levels 0–8 of the hierarchy above.

Foundational Questions (Level 1)

Q1. Why do humans discover structures?
(Connects to: H1, OP-01)

Q2. Why do humans perceive certain structures as non-random?
(Connects to: H5, OP-03)

Q3. Why do humans judge certain phenomena as meaningful?
(Connects to: H4, OP-02)

Q4. Where do research questions come from?
(Connects to: H6, OP-08)

Q5. How do humans and AI collaborate in the structure discovery process?
(Connects to: H1, H7, OP-06)

Extended Questions (Level 2)

Q6. Does something analogous to intuition exist in AI?
(Connects to: H1, H7, OP-06)

Q7. Does AI discover structures, or does it generate them?
(Connects to: H1, H7, OP-06)

Q8. Are structure discovery and meaning attribution the same process, or distinguishable?
(Connects to: H1, H4, H6)

Q9. What kind of cognitive profile characterizes a researcher?
(Connects to: H7 — researcher as explanation opportunity detector)

Q10. Will the future role of humans shift from computation toward structure discovery and significance evaluation?
(Connects to: H1, H7, OP-06)

Meta-Theoretical Questions (Level 3)

Q11. Can the significance filter (H4) be operationalized into a formal or computable model?
(Connects to: H4, OP-02)

Q12. Is explanatory significance detection (H6) a domain-general cognitive capacity, or domain-specific?
(Connects to: H6, H7)

Q13. What is the relationship between structural invariance (Papers 1–3) and explanatory significance?
(Connects to: H4, H6, OP-05)

Q14. Can concept generativity (H10) be measured or predicted before a concept is widely used?
(Connects to: H10, OP-07)

Q15. Does the Concept Evolution Cycle (H8–H9) have acceleration mechanisms — and if so, what are they?
(Connects to: H8, H9)

Cross-Level Questions

Some questions span multiple levels and cannot be cleanly assigned to one:

Question	Levels Spanned	Hypothesis Connections
What makes a structure feel "explanatorily pregnant"?	3 + 5	H4, H5, H6
Is there a unified cognitive mechanism underlying attention, significance, and explanation anticipation?	2 + 3 + 5	H3, H4, H5, H6
How does AI's role in discovery change as AI systems become more capable?	2 + 6	H1, H7, OP-06
Can the research generation cycle be deliberately initiated, or only recognized in retrospect?	1–5	H1–H7
Does the same question — "why does this pattern exist?" — operate differently in different domains?	0 + 3 + 5	H2, H4, H5

Program History as Question Evolution

The research program's central question has evolved through successive refinements.
This evolution is itself an example of the Concept Evolution Cycle (H9):

Stage	Central Question	Conceptual Enabler
Initial	Why does this checkerboard appear?	Karnaugh map as visualization tool
Early	Why do humans recognize patterns as structures?	Distinction between **pattern** and **structure**
Middle	Why do humans discover structures?	Concept of **discovery** as distinct from **recognition**
Later	Why do certain structures feel worth investigating?	Concept of **significance filter** (H4)
Current	How do humans detect explanatory significance?	Concept of **explanatory significance** (H6)
Program-level	How do humans come to see something new?	Concept of **concept as lens** (H8)

What this table shows: Each new central question appears to have required a new concept to become formulable.
This is consistent with the Concept Evolution Cycle (H9) operating in the research program's own history, but a single retrospective self-report is not a test of it.

Open Status Notice

All questions in this document are **open** unless explicitly marked otherwise.
No question should be marked as resolved without the researcher's explicit approval.

To add a new question:

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**Q[next number].** [Question text]
*(Connects to: [Hypotheses], [Open Problems])*
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To flag a question as having a candidate resolution, add:
`*Candidate resolution proposed — see [document reference]*`

Version history: v1.0 = initial structure (Level 0–5, Q1–Q10); v2.0 = expanded (Level 0–8, Q1–Q15, cross-level table, full hypothesis/OP connections, program history table)
Cross-reference: Hypotheses.md, OpenProblems.md, HANDOVER.md ("How Papers 1–3 Connect to SRT"), inha20/StructureRecognitionTheory_Unified.md (compressed SRT v0.3; full v0.3 text only in git 677bf7e^)
vNext candidate integrated: drafts/CoreQuestions_vNext.md (Levels 6–8 adopted)
Last Updated: 2026-06-06