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Article title: Computational Modeling of the Mind: What Role for Mental Representation?

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Abstract

The *classical computational theory of mind* (CTM) holds that many important mental processes are computations similar to those executed by Turing machines. This article compares two alternative frameworks through which one can develop CTM: *formal-syntactic computationalism* and *content-involving computationalism*. According to formal-syntactic computationalism, computation is sensitive to syntax but not semantics. Mental computation manipulates formal syntactic items without regard to any representational properties those items may have. According to content-involving computationalism, certain computational descriptions characterize mental states through their representational properties rather than any alleged formal syntactic properties. The article examines strengths and weaknesses of each framework.

In 1936, Alan Turing introduced an abstract mathematical model of an idealized computing device: the *Turing machine*.[1] Turing's model has proved remarkably influential within logic, computer science, and cognitive science. According to *the classical computational theory of mind* (CTM), many important mental processes are computations similar to those executed by Turing machines.[2-5] This view, sometimes also called *classical computationalism*, played a central role within cognitive science during the 1960s and 1970s. In the 1980s, a rival *connectionist* paradigm attracted many adherents. In the 1990s, CTM faced further challenges from *dynamical systems theory*, *computational neuroscience*, and the *embodied cognition movement*. CTM no longer enjoys anything like its former orthodox status. Nevertheless, it still finds prominent advocates within philosophy and cognitive science.

THE CLASSICAL COMPUTATIONAL THEORY OF MIND

A Turing machine contains a *central processor* and a *memory store*. The memory store has infinitely many *memory locations*. Turing visualizes these as cells on a two-way infinite paper tape, but one might physically realize memory locations using vacuum tubes, silicon chips, or various other media. A Turing machine manipulates primitive *symbols* drawn from a finite *alphabet*. The central processor inscribes or erases symbols in memory locations, depending on the current contents of a memory location and the processor's own state. A *machine table* encodes precise rules dictating how the central processor should proceed. Turing argued convincingly that this model can replicate any humanly executable mechanical procedure for manipulating symbols.

According to CTM, the mind is a computational system that resembles the Turing machine in important respects. Proponents do not slavishly follow the details of Turing's formalism. For example, they usually replace Turing's infinite memory store with a large, finite memory store. Many other changes are possible while preserving the main idea behind Turing's model: computation as rule-governed manipulation of symbols inscribed in read/write memory.

To endorse CTM is to accept that the mind computes over symbols. We must therefore elucidate the nature of "mental symbols." Turing's formalism provides little guidance, remaining almost entirely neutral regarding primitive symbols. As we will see, there is considerable debate regarding the mental symbols required by CTM.

Classical computationalists generally agree that primitive mental symbols can be compounded into complex symbols, just as words from natural language can be compounded into complex linguistic expressions. Jerry Fodor placed these ideas at center stage.[2,6] He postulated that thinking occurs in a *language of thought* (sometimes called *Mentalese*). To model high-level human thought, Fodor posits complex mental symbols with propositional structure akin to natural language sentences. It is controversial how closely Mentalese compounding mechanisms *in general* resemble linguistic compounding mechanisms. Some complex mental symbols may more closely resemble non-propositional representations such as maps, diagrams, or pictures.

Systematicity and productivity

Jerry Fodor and Zenon Pylyshyn offer a famous argument for classical computationalism, centered on two key phenomena[7,8]:

- *Systematicity*: An ability to entertain one thought is correlated with an ability to entertain others. For example, someone who can entertain the thought *that John loves Mary* can also entertain the thought *that Mary loves John*.
- *Productivity*: Neglecting incidental limits on lifespan and memory capacity, humans can entertain a potential infinity of thoughts.

If mental states are relations to Mentalese symbols, then we can explain both phenomena:

- *Systematicity*: Suppose I can think that John loves Mary. My doing so involves my standing in some relation R to a Mentalese sentence JOHN LOVES MARY, composed of Mentalese words JOHN, LOVES, and MARY combined in the right way. (We use capitalization to denote Mentalese expressions.) If I have this capacity, then I also have the capacity to stand in relation R to the distinct Mentalese sentence MARY LOVES JOHN, thereby thinking that Mary loves John. More generally, systematicity arises because one can decompose a complex

Mentalese expression into its parts and recombine those part to form other complex expressions.

- *Productivity*: Mentalese contains compounding devices that can be iteratively applied. For example, one can deploy logical connectives AND, OR, and NOT to generate ever more logically complex Mentalese sentences (e.g. EITHER JOHN LOVES MARY AND MARY LOVES JOHN OR JOHN DOES NOT LOVE MARY AND MARY DOES NOT LOVE JOHN). Iterative application of compounding devices generates infinitely many Mentalese expressions, yielding a potential infinity of possible mental states.

Fodor and Pylyshyn defend CTM by arguing that it provides our best explanation for systematicity and productivity.

Critics attack this argument from multiple angles. Some question whether human thought is systematic[9] or productive[10]. Others complain that the case for systematicity and productivity in non-human animals is weak.[11] Another common criticism is that the explanation for systematicity and productivity hinges upon complex symbols, rather than Turing-style computational architecture. For example, there are connectionist theories that posit complex mental symbols but reject the Turing machine paradigm.[12] These theories can arguably explain systematicity and perhaps also productivity.

C. R. Gallistel and Adam King offer a related productivity argument for CTM.[3] The argument emphasizes productivity of mental *computation*, rather than productivity of mental *states*. Gallistel and King canvass evidence that many animals can execute a huge number of potential computations. Consider the western scrub jay, which caches food to be retrieved during winter. The jay records where it cached food, what kind of food it cached in each location, when it cached the food, and whether it has depleted a cache.[13] It accesses these mental records and exploits them in diverse computations, such as computing whether a food item stored in some cache is likely to have decayed. There are many possible storage locations, storage dates, and rates of decay. One cannot tell in advance which pieces of information must be combined during mental computation. For example, the jay can record approximately 10,000 distinct cache locations, so there are vastly many route calculations between caches it might make. Thus, the jay can execute a huge number of unforeseen computations, whether or not the number is literally infinite.

CTM postulates complex mental symbols stored in read/write memory. When needed, the central processor retrieves arbitrary, unpredicted combinations of symbols from memory. This theory readily explains how animals can execute a vast number of unforeseen computations. The explanation turns upon symbol storage in read/write memory --- a key commitment of Turing-style architecture rejected by many connectionists and computational neuroscientists. According to Gallistel and King, these rival theorists have great difficulty explaining the productivity of mental computation. Rival theorists eschew read/write memory, but they propose no satisfactory alternative theory of how animals store information in computationally accessible form.

This new productivity argument has not yet received much discussion, aside from a few dissents (e.g. Ref 14). Nevertheless, it offers important advantages over the Fodor-Pylyshyn productivity argument. It applies straightforwardly to many non-human animals. It does not require tendentious commitment to a literal infinity of mental states. And it emphasizes how computation *uses* mental symbols, thereby showcasing the distinctive explanatory benefits afforded by Turing-style architecture.

MENTAL REPRESENTATION

Talk about "mental representation" pervades philosophical and scientific discussion of CTM. But what does it mean to describe mental states as "representational"? Within philosophy, the dominant usage ties mental representation to *representational content*. A representational mental state has a *content* that represents the world as being a certain way. We can evaluate whether the world is in fact that way. For example, my belief *that John loves Mary* is true iff John loves Mary, while my desire *to eat chocolate* is fulfilled iff I eat chocolate. (The phrase "iff" is an abbreviation for "if and only if".) Philosophers have offered detailed, and conflicting, theories of representational content.[15-17] For our purposes, what matters is the core idea that all these theories share: representational mental states can be evaluated against the world for semantic properties such as truth and fulfillment.

Fodor combines this core idea with CTM.[7] He claims that mental symbols are *mental representations*, i.e. mental items with representational properties. Mentalese has a *compositional semantics*: representational properties of a complex Mentalese expression are determined by representational properties of its components and the manner in which those components are combined. For example, the Mentalese word JOHN denotes John, the Mentalese word MARY denotes Mary, and the Mentalese word LOVES denotes the loving relation. These words combine to form the Mentalese sentence JOHN LOVES MARY, which is true iff John loves Mary. Contemporary discussion of compositionality builds upon seminal contributions by Gottlob Frege,[18] who analyzed propositional structures far more sophisticated than simple examples like JOHN LOVES MARY.

Frege made a further fundamental contribution to the study of mental representation. He adduced cases where a thinker does not recognize an entity as the same because she mentally represents that entity in different ways.[15] One may not realize *that Hesperus is Phosphorus*, even though Hesperus and Phosphorus are one and the same entity (Venus). One may not realize *that mercury is quicksilver*, or *that cilantro is coriander*, or *that groundhogs are woodchucks*. Frege analyzed such cases by postulating *modes of presentation*, or *ways of representing* entities. One can think about a single entity under different modes of presentation. Although some philosophers resist Frege's analysis,[19] classical computationalists usually follow him by postulating modes of presentation. They differ from him by enlisting mental symbols to serve as modes of presentation.[20] For example, one can postulate distinct Mentalese words MERCURY and QUICKSILVER that both denote mercury. These words reflect different ways of representing the same denotation. Thus, mental symbols facilitate the fine-grained differentiation of mental states that Frege cases demand.

THE FORMAL-SYNTACTIC CONCEPTION OF COMPUTATION

Classical computationalists usually presuppose *the formal-syntactic conception of computation* (FSC). Although precise formulations vary, the basic idea is that computation is sensitive to syntax but not semantics.[3,5,6,21,22] CTM and FSC jointly entail that mental computation manipulates mental symbols based solely on formal syntactic properties, rather than semantic or representational properties. The mind is a "syntactic engine."

To illustrate, consider the inference rule *conjunction elimination*:

p and q

______

p

Beginning with Frege,[18] logicians have delineated *formal languages* that contain linguistic expressions characterized solely by their geometric shapes. In this spirit, we can introduce a symbol "&", and we can formulate conjunction elimination as follows:

> From any complex sentence "S&T" (i.e. any complex sentence formed by writing sentence S followed directly by the symbol "&" followed directly by sentence T), one may infer the sentence S.

Intuitively, "&" means conjunction. More precisely, it expresses the standard *truth-table*, on which a conjunction is true iff each conjunct is true.[17] But we ignore this intended meaning when formulating our inference rule. The rule mentions geometric shapes rather than meanings.

CTM+FSC extends these ideas to mental computation. Mechanical rules govern how the mind manipulates mental symbols. When we delineate those rules, we mention only formal (i.e. non-semantic) properties akin to geometric shape. We do *not* mention denotation, truth, or any other semantic properties. We describe mental states and processes in purely syntactic, non-representational terms. A symbol's formal syntactic properties, as opposed to any representational properties it may have, determine how mental computation manipulates it. Syntax rather than semantics "drives computation forward." Call this position *formal-syntactic computationalism*.

What is mental syntax?

Mental states do not have literal shapes relevant to psychological explanation. What are the formal syntactic properties of Mentalese symbols, analogous to the geometric shapes emphasized by logicians?

We may sharpen the issue by distinguishing between *types* and *tokens*. Mental symbols are *repeatable*: a symbol can occur and re-occur in the mental activity of one thinker or more. Different occurrences involve different *tokens* of a single *type*. Under what conditions do tokens count as tokens of a single Mentalese type? How should we *type-identify* mental symbols when delineating the rules that govern mental computation?

One might hope to type-identify Mentalese symbols through neural or physical properties. However, this proposal conflicts with a widespread commitment among classical computationalists to *multiple realizability*. As Hilary Putnam highlighted,[4] and as David Marr subsequently emphasized,[23] computational description prescinds from physical implementation details. It specifies abstract properties that could be realized by diverse physical substrates. In principle, a Turing-style model of the mind could apply just as well to a Martian built from silicon chips. Setting aside science fiction scenarios, it seems that we can often apply the same computational explanation to subjects whose neural properties vary, or to a subject whose neural properties change over time (e.g. due to brain damage). Formal-syntactic computationalists usually conclude that we should type-identify mental symbols through abstract syntactic properties that allow diverse neural or physical realizations.

What are these syntactic properties? One popular strategy is to type-identify mental symbols through "functional," "conceptual," or "computational" role --- roughly, the role that a symbol plays in psychological activity.[20,22,24] For example, one might postulate a Mentalese word AND type-identified by the inference rules governing its role in reasoning. It has proved difficult to develop this approach convincingly even for logical connectives, and the difficulties ramify when one considers non-logical mental representations.[25,26] At present, we lack a widely accepted analysis of formal mental syntax.[27]

Mental syntax and psychological explanation

CTM+FSC models mental activity as manipulation of formal syntactic items. Yet some critics question whether formal syntactic manipulation plays any significant role within the proper psychological explanation of certain core mental phenomena.

Consider conjunction elimination. When I transit from a belief *that p and q* to a belief *that p*, I transit between mental states with representational content. The specific content *p* and the specific content *q* may not inform my reasoning, but the content of the primary logical connective is highly relevant. I apprehend the conjunctive structure of my thought, and my reasoning is sensitive to that structure. The content of the primary logical connective, rather than any putative formal syntax that it contributes, seems most relevant to explaining why I reason as I do. Arguing along these lines, Tyler Burge rejects a formal-syntactic picture of deductive reasoning.[28] On Burge's approach, deductive reasoning operates over mental states with propositional structure, built from logical connectives whose contents help explain why reasoning proceeds as it does. The connectives lack explanatorily significant formal syntactic properties. True, logicians study formal inference rules defined over geometric shapes. But those inferences rules are mathematical abstractions from the root psychological phenomenon: reasoning over contentful propositional structures.

Formal-syntactic computationalists will reply that formal mental syntax underlies our best scientific treatment of deductive reasoning. However, cognitive science practice does not provide obvious support for this assessment. There are several conflicting theories of deductive reasoning,[29] none of which assigns evident explanatory weight to formal mental syntax. Consider Lance Rips's *mental logic* theory, which holds that deductive reasoning manipulates mental representations in conformity with precise inference rules.[30] One rule is a version of conjunction elimination. When stating the rule, Rips does not attribute formal syntactic properties to the connective AND. On the contrary, he treats it as a repeatable item that contributes conjunctive structure. Although Rips's theory is sometimes described as "formal syntactic," it in fact only disregards *non-logical* content. For example, it disregards the content *p* and the content *q* in the belief *that p and q* while emphasizing the meaningful connective that links those contents into a conjunctive thought. When identifying this connective, Rips cites its semantic contribution to complex mental sentences (namely, that a mental sentence P AND Q is true iff P is true and Q is true).

Burge extends his critique of CTM+FSC beyond deductive reasoning to additional phenomena, ranging from higher-level cognition (e.g. theoretical and practical reasoning) to subpersonal processing (e.g. perception). In many cases, he claims, cognitive science identifies mental states through their representational properties *rather than* any alleged formal syntactic properties. For example, perceptual psychology describes the perceptual system as transiting from sensory stimulations (e.g. retinal stimulations) to perceptual states that represent distal shapes, sizes, colors, and so on. These descriptions characterize perceptual states representationally --- *as* representations of specific distal shapes, sizes, and colors. In contrast, perceptual psychology does not attribute formal syntactic properties to perceptual states.[31]

The critique here is not just that representation plays an important role in cognitive science. Fodor and many other formal-syntactic computationalists would happily acknowledge as much. The critique is that cognitive science explanation in many areas (including deduction and perception) hinges upon representational content *as opposed to* formal syntax. Scientific practice provides no evidence that the relevant mental processes manipulate formal syntactic items, let alone that the processes are sensitive solely to syntax rather than semantics. This critique is compatible with many different theories of representational content. For example, it assumes little about the content of AND save that this content determines the truth-table for conjunction.[a] Similarly, it assumes little about the contents of perceptual states save that those contents determine appropriate represented distal properties (e.g. shapes, sizes, and colors).

We must carefully distinguish between *syntactic* and *neurophysiological* description. Everyone agrees that a finished cognitive science will assign great importance to neurophysiological description. But syntactic description is supposed to be multiply realizable in the neurophysiological. The issue here is whether cognitive science should offer *non-representational, multiply realizable formal syntactic descriptions* of mental states.

CONTENT-INVOLVING COMPUTATION

A few philosophers espouse an alternative computational framework that prioritizes representational content.[31-38] On the alternative approach, certain computational descriptions characterize mental states through their representational properties rather than any alleged formal syntactic properties. Adapting Christopher Peacocke's terminology,[35] let us call this position *content-involving computationalism*. Proponents often motivate content-involving computationalism by adducing explanatory practice within cognitive science. They claim that representational content *rather than* formal syntax is explanatorily central to numerous core areas, such as the study of perception and deductive reasoning. The basic goal is to delineate computational models that likewise assign explanatory priority to representational content rather than formal syntax.

Formal-syntactic computationalism and content-involving computationalism are compatible. A theorist who employs content-involving computational descriptions can simultaneously hold that the relevant computations are sensitive to syntax but not semantics.[6] However, many content-involving computationalists reject formal-syntactic computationalism.[33-34,37] Tyler Burge[34,40] and Michael Rescorla[37] question whether formal-syntactic description adds any explanatory value to content-involving description. They question whether we can "hive off" a mental state's representational properties to obtain a psychologically significant formal syntactic bearer of those properties.[b]

How should one develop content-involving computationalism? Murat Aydede[32] and Michael Rescorla[36,37] recommend that we introduce mental representations *type-identified partly by their semantic properties*. One can then model mental activity as Turing-style computation over these "inherently meaningful" representations.

To illustrate, suppose we postulate a mental representation AND that necessarily expresses conjunction. Every token of a mental sentence P AND Q is true iff P is true and Q is true. In that respect, AND differs from the concrete symbol "&", which could have expressed disjunction rather than conjunction. "&" is a piece of formal syntax subject to reinterpretation. AND is not. Precise rules describe how mental computation manipulates complex mental representations containing AND. For example, conjunction elimination dictates that one transit from a conjunctive belief to a belief in the first conjunct. More generally, we may posit mental logical connectives with inherent semantic import. Deductive reasoning manipulates complex expressions built from these connectives. When delineating the rules that govern deductive reasoning, we do not attribute a content-neutral syntax to connectives. Instead, we type-identify connectives partly through the semantic properties that they contribute to complex propositional structures.

Generalizing, we may treat mental computation as rule-governed manipulation of symbols type-identified partly by their representational properties. There is a mental representation CHAIR that necessarily denotes chairs, a mental representation LOVES that necessarily denotes the loving relation, and so on. For example, if a representation does not denote chairs, then it is not the mental representation CHAIR. In this respect, it differs from the English word-form "chair," which might have denoted tables rather than chairs had our linguistic conventions been different. Precise rules describe how to manipulate mental representations inscribed in read/write memory. One such rule might mandate that the central processor erase CHAIR from a memory location under certain conditions. When delineating these rules, we characterize mental symbols at least partly through their representational import.

One might worry that "inherently meaningful" mental representations are rather dubious entities (Ref. 39, pp. 21-22). How can a mental symbol have its denotation *necessarily*? What magic ensures this necessary connection between symbol and denotation? To address these worries, recall the distinction between *type* and *token*. There is nothing magical about a taxonomic scheme that type-identifies tokens at least partly through their semantic properties (Ref. 40, p.302). For example, there is nothing magical about classifying mental states partly based upon whether they represent chairs. By citing symbol types with necessary semantic properties, we do not thereby posit entities with supernatural powers. We simply use semantic properties as a partial basis for grouping tokens into types.

How can content-involving computationalists handle Frege cases? They can postulate distinct mental representations MERCURY and QUICKSILVER, each necessarily denoting the substance mercury. All tokens of type MERCURY denote mercury. All tokens of type QUICKSILVER denote mercury. Nevertheless, these are distinct Mentalese words --- different modes of presentation that represent the same denotation. Thus, contrary to what some critics[24] suggest, content-involving computationalism can differentiate mental states in fine-grained fashion.

A major challenge here is to elucidate "inherently meaningful" mental representations. How are these representations type-identified, if not solely by their denotations? For example, what differentiates the representations MERCURY and QUICKSILVER? This challenge is analogous to one that faces formal-syntactic computationalism: elucidating formal syntactic properties. Proponents of "inherently meaningful" mental representations must address the challenge in depth.

As already noted, Turing's formalism remains fairly neutral regarding the nature of symbols. The formalism lets us type-identify mental symbols in either formal-syntactic terms *or* content-involving terms.[37] Thus, formal-syntactic computationalism and content-involving computationalism can both secure the benefits of Turing-style architecture. In particular, either framework can readily explain the productivity of mental computation. That being said, some content-involving computationalists do not endorse classical computationalism.[34]

EXTERNALISM ABOUT MENTAL CONTENT

Externalism about mental content, a philosophical theory that emerged in the late 1970s through writings of Putnam and Burge,[4,40] has long played a central role in philosophical discussions of computation and mental representation. Externalism holds that a mental state's content is fixed partly by causal relations to the external environment, relations that outstrip the thinker's internal neurophysiological properties. Externalists defend this position through thought experiments, abstract theoretical arguments, and appeals to cognitive science practice.[40] According to externalism, two internal neurophysiological duplicates who bear sufficiently different relations to the external environment will instantiate mental states with different representational contents. For example, suppose that Oscar mentally represents the substance water (i.e. H_2O). According to externalism, there could be a neurophysiological duplicate Twin-Oscar who mentally represents some qualitatively similar but distinct substance with a different chemical composition XYZ.[4] Whether a thinker represents H_2O or XYZ depends on which substance has figured appropriately in the thinker's causal interactions with the external environment.

Internalists regard externalism warily. They want to "factor out" externally determined aspects of representational content. They claim that (at least some) psychological explanations should cite only psychological properties shared by neurophysiological duplicates, ignoring any environmentally-determined differences.[6,7,22] Formal-syntactic computationalism is one way to develop internalism. For example, proponents can say that Oscar and Twin-Oscar share the same Mentalese formal syntactic type WATER, which denotes H_2O when used by Oscar and XYZ when used by Twin-Oscar.

One can develop content-involving computationalism in either an internalist direction[32] or an externalist direction[31,36]. On an internalist approach, one tries to isolate explanatorily significant content-involving properties shared by all neurophysiological duplicates. On an externalist approach, computational descriptions can freely cite representational properties that outstrip internal neurophysiology. Depending on the details, formal-syntactic description and internalist content-involving description may not differ so markedly. However, formal-syntactic description and externalist content-involving description differ significantly. The former, unlike the latter, applies uniformly to neurophysiological duplicates. Externalists question whether we can "factor out" external considerations to delineate explanatorily valuable syntactic descriptions that uniformly encompass neurophysiological duplicates.[31,36]

IMPLEMENTATION MECHANISMS

A prominent argument for formal-syntactic computationalism emphasizes *implementation mechanisms*. Semantic properties only impact mental activity as mediated by non-semantic properties. A complete theory must explain in non-representational terms how the mind transits between representational mental states. Formal syntactic modeling provides the needed implementation mechanism. So we require formal-syntactic descriptions instead of, or in addition to, content-involving descriptions.[7] This argument looks particularly compelling in light of content externalism. How can external causal relations impact mental activity, except as mediated by "local" brain states? Shouldn't we isolate a "local" implementation mechanism that applies uniformly to all neurophysiological duplicates?[6,20]

Opponents of formal-syntactic computationalism pursue various replies.[31,38] One reply grants that we need a "local" implementation mechanism while denying that the mechanism must be syntactic.[37] Neural activity physically realizes mental activity, so it is natural to pursue a neuroscientific theory of implementation mechanisms. What advantage would we gain by replacing or supplementing a satisfying neuroscientific theory with a formal-syntactic description? If multiple realizability is our goal, then content-involving computational descriptions already achieve that goal. Why must our theory of implementation mechanisms likewise be multiply realizable? Proponents of formal-syntactic description respond that a good theory of implementation mechanisms should abstract away from neural details, at least for certain purposes.[41] Debate over these fundamental questions seems likely to continue into the near future.

Conclusion

We have examined two frameworks through which one might develop CTM: formal-syntactic computationalism and content-involving computationalism. The first framework receives far more philosophical attention. However, the second has much to recommend it. Future research should clarify each framework on its own terms. Perhaps most pressingly, all parties must explain more fully how mental symbols are type-identified. As already emphasized, the two frameworks are not mutually exclusive. One might espouse a hybrid position that allows both formal-syntactic types *and* inherently meaningful mental symbols. Or one might apply the formal-syntactic framework to certain mental phenomena and the content-involving framework to others. Future research should systematically explore which computational framework is better suited to which mental phenomena.

Notes

[a] Some philosophers hold that a logical connective's conceptual role determines its semantic properties.[42] For example, one might hold that the inference rules governing conjunction determine the standard truth-table for conjunction. If one agrees, then conceptual roles do not seem like good candidates to elucidate putative "formal syntactic properties" of logical connectives. Certainly, conceptual roles would differ significantly from geometric shapes, which leave semantics unconstrained.

[b] Quite plausibly, one can hive off *certain* representational properties in *certain* cases. To illustrate, consider *demonstrative mental representation*. If I demonstratively represent a perceived cup (e.g. THAT CUP IS RED), then it seems plausible that one can ignore the particular context-determined cup when studying the relevant mental demonstrative (THAT CUP). Even in this case, it is not evident that any psychologically significant residue remains if one ignores *all* the mental state's representational properties, such as that it represents some perceived cup or other

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