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METAPHOR AND TRUTH: A REVIEW OF *REPRESENTATION RECONSIDERED* BY W. M. RAMSEY

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ABSTRACT: William M. Ramsey's *Representation Reconsidered* (Cambridge University Press, New York, 2007) is a critical evaluation of the use of representational notions in cognitive science. Ramsey distinguishes different types of representational posits and argues that only one of them, the sort of structured representation that is assumed in the computational theory of mind, remains true to representationalism. Other uses of "representation" are more akin to the concepts of receptor, transduction, or causal mediation, and do not entail any actual representational role. In recent times, the increasing use of representational notions of the latter kind leads Ramsey to suspect that under the cover of its representational umbrella, cognitive science is actually moving back to behaviorism. Regardless of its conclusions, Ramsey's book is highly readable, philosophically careful, and provocative. It uncovers widespread ambiguity and confusion in cognitive science. By Ramsey's own analysis, however, it is the validity of all concepts of internal representation, not just some of them, that can be questioned. Whatever scientific truths lurk behind the representational narrative, they are best uncovered and characterized without appealing to any concept of representation.
Key words: representation, computation, cognition, metaphor, truth

> If one thing is to stand for or to represent another we must have direct knowledge both of the thing represented and of the symbol. (Nunn, 1909-1910, p. 198)

In *Representation Reconsidered*, William Ramsey (2007) examines different notions of representation currently in use among cognitive scientists. His perspective is that of a philosopher of science. Through conceptual analysis, he argues that in current cognitive science, the label "representation" hides a variety of notions, and that some of them have more in common with behaviorism than what cognitive scientists may be willing to acknowledge.

Ramsey's argument is part of a growing turmoil in cognitive science about the concept of representation and its applicability to natural and artificial systems. Cognitive science was organized historically around the joint concepts of representation and computation (Pylyshyn, 1984). As the discipline evolved,

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however, new contenders to psychological explanation such as connectionism (e.g., Smolensky, 1988), dynamicism (e.g., Port & van Gelder, 1995), and radical embodiment (e.g., Chemero, 2009) have challenged the orthodox conception of the mind as a representational system. One such challenge was offered by van Gelder (1995), who suggested, using the Watt governor as an example of a machine devoid of representations, that cognition was more akin to a nonrepresentational dynamical system than to a digital computer. Van Gelder's proposal was met with a number of objections from defenders of the representational standpoint. Bechtel (1998), in particular, argued that the functioning of the Watt governor actually involved representations. For example, Bechtel claimed that in the Watt governor the angle of the arms *represented* the speed of the flywheel.

The most likely explanation for the divergence of views between van Gelder (1995) and Bechtel (1998) is that contrasting conceptions of representation were at work. The lack of resolution in this debate has important implications for cognitive science, however. As Haselager, de Groot, and van Rappard (2003) explain:

> Cognitive science can no longer tolerate a situation in which its core concepts allow extremely conflicting positions on whether or not a relatively simple system like the Watt Governor is representational. In our view, the value of these recent debates consists in emphasizing the need for a more stringent definition of representation and computation. (p. 21)

The main purpose of Ramsey's book is to fulfill this need. His is not the first attempt at clarifying the meanings of "representation" at work in cognitive science, but *Representation Reconsidered* is the most careful, extensive, and detailed so far.

Reconsidering Representation

Most philosophical work on representations has focused on representational content. A representation such as the picture of a rabbit is always a representation *of* something (its content; in this case a rabbit), and the issue of representational content is to explain how representations come to have the content that they have. Ramsey, however, focuses on another question: What kinds of properties does a thing need to have in order to *be* a representation?

This question is both important and troubling. On the one hand, the neural systems that cognitive scientists assume are representational are physical systems and can be described in purely physical terms. So the hypothesis that a cognitive system functions with representations is never strictly necessary to explain its functioning (p. 33; here, as elsewhere, page numbers without references pertain to Ramsey, 2007). On the other hand, with enough laxity in the use of computational or representational language, anything could be described trivially as relying on representations (Putnam, 1988). For example, the stomach could be claimed to "compute" or "represent" mathematical functions on the ground that during digestion it moves from one state to another and that its state transitions can be described mathematically (Searle, 1994).

Thus, if cognitive systems, and only cognitive systems, work by representing, a proper definition of "representation" needs to be sufficiently weak to allow for the existence of representations, but not so weak as to imply that representation is ubiquitous. Perhaps because most cognitive scientists take the existence of mental representations as an axiom, in Ramsey's book the second horn of the dilemma looms larger than the first. Ramsey reviews and criticizes overgeneral definitions of "representation," according to which cold beers designate food (p. 9), rocks know how to roll down a hill (p. 171), and a climber's blood represents elevation (p. 145). Not only do overgeneral theories of representation make the concept scientifically useless, they also belie reality by claiming of what is not a representation that it is. Ramsey drives the point home with the example of a theorist who would invoke a pump to account for some biological phenomenon:

> Suppose someone offers an account of some organic process, and suppose this account posits the existence of a structure that is characterized as a pump. . .when we ask how it is that the structure in question functions as a pump, we are told that it does so by absorbing some chemical compound, and nothing more. In this scenario, we would properly complain that the role the structure is characterized as playing is not the role associated with our ordinary understanding of a pump. To be a pump, an entity must, in some way, transfer material from one place to another. What the theory appears to posit is not a pump, but instead what sounds more like a sponge. (p. 28)

As Ramsey underscores, in these conditions it would not just be useless to refer to the postulated structure as a "pump." It would be wrong.

The same argument applies to any theory that posits representations (p. 11). To qualify as representations, the postulated entities must *recognizably* function as representations. This, in turn, requires some connection between the postulated representations and our ordinary, pre-scientific understanding of representation. The latter makes room for two classes of representations: (a) the mental ones, such as sensory states, perceptions, memories, and dream experiences; and (b) the nonmental ones, such as "linguistic symbols, pictures, drawings, maps, books, religious icons, traffic signals and signs, tree rings, compass needle positions, tracks in the snow, hand signals, flashing lights" (p. 20). It is the second class of examples that ground cognitivist explications of the concept of representation. Although Ramsey does not say so, a good reason for appealing to examples of the second kind rather than the first is the hopelessness of clarifying the mental by appealing to the mental.

By looking at ordinary examples of nonmental representations, then, we should be able to elucidate the concept of representation and decide whether the entities postulated in a given theory of cognition qualify or not as representational. Now, it is widely acknowledged that in the case of a nonmental representation X (for example, the picture of a rabbit), what makes X into a representation is the way in which X is used rather than any intrinsic property of X. Ramsey makes the point simply and elegantly:

> The proverbial driftwood washed up on an uninhabited beach does not, intuitively, represent anything, even if it happens to spell out the word "UNINHABITED BEACH" or is arranged in a way that maps a course to a nearby lake. However, if someone were to come along and use the driftwood as a type of map, then it would indeed take on a representational role. (p. 23)

In short, nothing qualifies as a representation unless it is *used* as a representation—used to symbolize, denote, "refer to," or "stand for" something else. However, this constraint on the concept of representation makes it difficult to see how there could be representations inside a person's brain, which is where the representations posited in cognitive science are typically supposed to reside. External representations like pictures or maps qualify as representations because *we* use them as such. Who uses the internal representations postulated in cognitive theory? And who uses them *as* representations?

Clearly, unless one postulates a homunculus who uses these representations for his own representational purposes, the functioning of an internal representation (what makes it a representation) cannot be exactly identical to the functioning of an ordinary, external, nonmental representation. At the same time, the hypothesized functioning of the internal representation must still be recognizably representational in nature, otherwise the postulated representation would not *be* a representation. How these opposing constraints can be met is far from obvious. Ramsey nevertheless believes that they can be met, and have actually been met in some cases. More precisely, he believes that *some* of the representations postulated in cognitive science are sufficiently similar to ordinary, nonmental representations to make it true that the postulated entities are actual representations (as when a biological "pump" actually functions like a pump), whereas in other cases, the postulated "representations" are not representations at all, as when an alleged "pump" turns out to function like a sponge.

To Be or Not to Be a Representation

According to Ramsey, two types of "representation" postulated in cognitive science involve genuine representational functions. Ramsey's argument for representations of the first type, which he calls IO-representations ("IO" for "input–output"), starts from the fact that some of the inputs and outputs of a cognitive system are conventional representations. For example, when someone is asked to compute 23 times 57, "23" and "57," as well as the person's answering "1311," are concrete numerals that represent abstract numerosities. Now a computational theory of the multiplication process will decompose it in various subprocesses, for example, a sequence of additions. They will require their own inputs and outputs, which are counterparts to the "23," "57," and "1311" tokens serving as representations with respect to multiplication as a whole. Ramsey argues that these internal analogs of queries and replies are representations because "we recognize that systems doing things like addition, or comparing chess moves, treat their inputs and outputs as symbols standing for things like numbers or chess game

scenarios" (p. 74). Later, however, he expresses doubts as to whether IO-representations actually play a representational role or merely seem to do so.

Ramsey's doubts do not extend to a second type of representational posits, which he calls S-representations ("S" for "simulation" or "structure") and takes to be robustly representational. The basic idea behind S-representation is that of an isomorphic correspondence between two systems, X and Y (Palmer, 1978; Swoyer, 1991). X functions as a representation of Y if X and Y are isomorphic and provided X is used as a surrogate of Y during problem solving.[1] The entity that engages in problem solving attempts could be a person, an animal, or a machine. Although Ramsey does not say so, the proviso about *using* X allows him to deflect an obvious objection to the notion of representation as isomorphism, namely that isomorphisms are symmetrical (if X is isomorphic to Y, then Y is isomorphic to X) whereas representation is not (a picture can represent a rabbit, but the rabbit does not thereby represent its picture). This proviso is also absolutely necessary from Ramsey's perspective because no formal aspect of X, in and by itself, could make it into a representation. Remember the driftwood that looks like a map; it does not qualify as a representation unless it is used as such.

Ramsey's concept of S-representation thus coincides largely with Gallistel's definition of representation as a *functioning* isomorphism (Gallistel, 1993, p. 30). Ramsey refers to S-representations, or parts thereof, as "elements of a model or simulation" (p. 87) and describes the accompanying process as "surrogative reasoning" (p. 83). The cognitive system that solves a problem successfully by employing S-representations succeeds precisely *because* the S-representations are isomorphic to aspects of the problem-solving domain (p. 85). The nature of the problem being solved also fixes the content of the S-representation. When a rat orients itself in a maze by using an S-representation of it, the S-representation may be isomorphic to all sorts of things beyond the structure of the maze. (This multiplicity of isomorphs is the basis of a standard objection to the theory of representation as isomorphism. Objectors assert that on the isomorphic conception, representational content is underdetermined.) On Ramsey's conception, however, the rat's S-representation represents the maze, and the maze only, because as a matter of fact this is the maze that the animal negotiates (p. 95). Finally, the notion of S-representation allows Ramsey to meet the main challenge that he has himself identified: explaining how an entity that is only part of a cognitive agent could function as a representation. As he states:

> It should be clear how, on this conception, brain states that are posited as part of a computational process (brain states that function as data structures) actually *serve as* representations in such a process. They do so by serving as constituent elements of a model or simulation that is exploited by the system when doing some cognitive task. (p. 87)

[1] Here the correspondence between X and Y is supposed to be bijective, but this condition can be relaxed and the concept of isomorphism replaced by that of homomorphism (Swoyer, 1991). In this article I will stick to isomorphisms for simplicity.

Both IO- and S-representations are fundamental posits of what Ramsey calls "the classical computational theory of cognition" (CCTC, p. 2), and they fulfill his requirements for a coherent philosophical conception of representation. There are two other notions of representation, however, that fail to so. These notions are those of receptor and tacit representation. They figure prominently in neuroscience, connectionism, and other approaches that depart from CCTC.

The basic idea behind the receptor notion of representation is that an internal change X qualifies as a representation of some feature or entity Y whenever X responds reliably to Y. It is in this sense that a cell or group of cells in the brain is said to "represent," "signal," or "carry information" about Y. In all cases, what grounds the representational role of X is the causal or nomic dependency relation between Y and X. Now, an obvious shortcoming of this notion of representation is its overgenerality. In a sufficiently loose sense of "information," any physical effect may be said to "represent" or "carry information" about its causes. However, the receptor notion of representation can be strengthened by appealing to natural selection and requiring of X to have been conserved across generations for being a causal mediator between Y and behavior. To qualify as a representation of Y, then, not only must X reliably respond to Y, but it must be its biological *function* to do so (Dretske, 1988).

Against this approach to representation, Ramsey objects that receptors, even receptors that have been selected for, fail to play a representational role. For example, the firing pin in a gun mediates causally between pulling the trigger and the gun's firing, and its presence in the gun is certainly no accident. In fact, guns are carefully designed so as to incorporate a firing pin. Yet a firing pin does not represent anything (p. 136). Another counterexample to the receptor notion involves Ramsey planting a tree in his backyard so as to profit from the shade. The length of the tree's shadow is causally related to the position of the sun, and the tree has been planted in the yard because of this causal relation. Yet in this case, the shadow does not represent anything. The problem is that the tree's shadow is not used *as* a representation—only as a shade.

The last notion of representation, that of tacit representation, similarly fails. Although not entirely absent from CCTC, this notion has been invoked mainly by connectionist modelers, who argue that their networks exhibit some form of "tacit representation" or "tacit knowledge." The ground for this attribution is that the system being modeled exhibits appropriate behavior in response to input patterns. Thus, a connectionist network may be said to represent some categories implicitly if presenting category members as input leads to differential output that respects the category boundaries. Against this approach to representation, Ramsey notes that "tacit representation" does nothing more than to describe a change of dispositions or input–output relations, and that on this ground everything is a representation. Copy machines know how to collate papers, and vases represent the fact that they break if hit hard enough. A concept of representation with this degree of generality is scientifically vacuous (p. 177).

Representation and Behaviorism

Although Ramsey distinguishes *bona fide* representations from receptors and tacit dispositions, he does so for the purpose of philosophical clarification and refrains from adjudging their relative empirical merits. Nowhere does he argue, for example, that S-representations are scientifically preferable to connectionist or dynamicist models. He does comment, however, on the fate of representational concepts, ersatz or genuine, in cognitive science. The last thirty years have seen an increasing prevalence of connectionist and neuroscientific research that relies on the notions of receptor and tacit representation. Because these notions, according to Ramsey, are not really representational, he suggests that cognitive science is in part moving back to behaviorism.

Whether Ramsey's verdict of a "revolution in reverse" (p. 223) is correct, however, depends at the very least on what one means by "behaviorism." It is true, as Ramsey reminds his readers, that the behaviorists never denied the existence of the nervous system, and that some forms of behaviorism have made room for proximal determinants of behavior in the guise of S-R mediators (Hull, 1930) and private events (Skinner, 1976). In fact, Hull (1930) once appealed explicitly to structured representations:

> Sequences in the outer world evoke parallel reaction sequences in sensitive organisms. By the principle of redintegration the organismic sequences acquire a tendency to run off by themselves, independently of the original world sequences. The organism has thus acquired an intimate functional copy of the world sequence, which is a kind of knowledge. (p. 523)

Here the "intimate functional copy" that Hull postulates is isomorphic to a portion of the environment (in the sense of preserving ordering relations in time) and supports the animal's problem-solving efforts. Hence it fully qualifies as an S-representation. (Ramsey denies this, p. 225, but on grounds that are unclear to me.)

Now, Ramsey is not the first to note the similarity of an important portion of cognitive science and mediational behaviorism (e.g., Moore, 1982). In either case, behavior is explained through internal processes described mainly in the language of causal mediation and neural networks. However, there is another version of behaviorism, a nonmediational one that is definitely present (although to different degrees and not always consistently) in Kantor, Skinner, and Gibson. In contrast to Hullian theory and its sequels, nonmediational behaviorism emphasizes the transdermal nature of each psychological event and its historical explanation through past interactions with the environment. A shift from S-representations to neurally inspired networks is not a return to nonmediational behaviorism, but a switch from one version of mediational behaviorism to another (Malone, 1990).

What would nonmediational behaviorists think of Ramsey's attempts at clarifying the concept of representation? On the one hand, the scientific characterization of the neural machinery behind behavior is part of another discipline with its own subject matter (Smith, 1994). To the extent that it deals with neural events, the choice between S-representations and receptor notions of

representation is irrelevant to nonmediational behaviorism. On the other hand, the concept of internal representation is a cornerstone of mentalism, which promotes itself as a competitor to environmental explanations of behavior (e.g., Fodor, 1975). Nonmediational behaviorists may therefore sympathize with Ramsey's clarification attempts and with his criticism of the cognitivist overuse of representational concepts. But can the concept of representation be clarified and retain any scientific validity?

The Trouble with Representation

As Ramsey notes, representational explanations in cognitive science are riddled with confusion. They are also remarkable for the ubiquity and certainty with which they are invoked to explain all but the simplest unconditional reflexes (e.g., Roitblat, 1982). Attributing complex behavior to representations is what Branch (1986) has called a cognitivist's "must." Ramsey finds the unclarity of representational attributions embarrassing (p. 221), but more than the unclarity, it is the unusual confidence with which such attributions are made that should worry him. This confidence is not a sign of good science. Data always have more than one possible explanation, and certainty in physical and biological sciences ("there must be a magnetic field around the earth") it is the end result of a lengthy selection process through which the currently accepted theory survived empirical testing as well as challenges from competitors. In cognitive psychology, however, representational attributions are not the result of, but the prerequisite for, theoretical development. Representations are invoked even *before* the theory starts. Finally, cognitive psychologists do not propose that some brain processes are merely *analogous* to representations—in which case we could discuss sensibly in what respects the analogy holds and in what respects it does not. Rather, cognitive psychologists propose that some brain processes literally *are* representations.

This unique mix of obscurity, ubiquity, certainty, and literality needs to be explained. Clearly, representational concepts are not invoked for mundane scientific reasons. These concepts instead reflect deeply held prescientific commitments that arose in specific historical circumstances. "Representation" comes through the Old French from the Latin idioms of "repraesentatio" and "repraesentare," meaning, variously, payment, illustration, or bringing something to the mind (Lagerlund, 2007). From the twelfth century onward, the concept of representation was deployed more systematically in relation with sensation, imagination, and memory. Later authors also connected the concept of representation with signs and linguistic symbols. Thus, the application of representational concepts to the brain (as is now commonly the case in cognitive science) does not express a direct analogy from one research domain to another, but an indirect one via a substantive theory of the soul or mind (Lagerlund, 2007). Medieval philosophical concepts about the mind have been transposed to the brain through the explicit identification of the former with the latter (e.g., "the mind is what the brain does"; Pinker, 1997, p. 21).

It is this commitment to a philosophical stance, not any particular aspect of the data, that explains the strength of conviction, in some quarters, that psychological explanation must be representational. In this sense, van Gelder (1995) was certainly correct when he pointed out how classical cognitive science embodied the Cartesian view of the mind as a representational engine. Taking representational descriptions of the brain to be literally true, instead of merely analogical, also legitimizes Ramsey's strategy of judging representational posits in terms of their correspondence, or lack thereof, to what one would ordinarily call a representation. Unfortunately, although aware of the difficulty of taking the notion of mental representation literally (p. 221), Ramsey fails to realize how doomed representationalism actually is.

Remember the crucial ingredient of representation, according to Ramsey, the defining element that makes of an entity a representation. An entity X qualifies as a representation if and only if it *used* as a representation. Ramsey, however, is never entirely clear on what this use is supposed to consist of. Ordinary representation is rooted in a set of social practices and contexts, as when someone uses X to represent Y as being such and such (van Fraassen, 2008). It would be absurd to suppose that these social factors are present in the case of neural states, and Ramsey wisely avoids doing so. If social practices are needed to make of an entity X a representation, however, Ramsey should conclude that there are no representations in the brain and that there cannot be any. As we have seen, he distinguishes mere causal relays from isomorphs of the environment and argues that only the latter fulfill a representational rule. But that an entity X is isomorphic to some environmental structure Y is no substitute for X being *used* (socially?) as a representation of Y. By Ramsey's own analysis, it is usage, not isomorphism, that makes of an entity a representation (Sprevak, 2011). Just as there are non-isomorphs that can be used as representations, and therefore *are* representations (as when white smoke is used to announce the election of the pope), some isomorphs fail to be used as representations and therefore are not representations (recall the example of the logwood on the beach).[2] An analysis of representation in terms of isomorphism necessarily fails.

Could Ramsey strengthen his analysis by adding to the isomorphism between X and Y some extra condition that would confer a representational role on X without invoking social practices? At times Ramsey suggests that an isomorph qualifies as a representation provided it supports "learning" (p. 141), "reasoning"

[2] Strictly speaking, it is a mistake to refer to a set of causal relays, such as the different types of smokes B and D used during the papal conclave, as nonisomorphic to the set of its causes. Imagine, for example, that A causes B and that C causes D. A being different from C and B being different from D, the structures <{A, C}, difference> and <{B, D}, difference> will be isomorphic to each other. The isomorphism in question, however, involves no other relation or property than the difference between two events and can be considered trivial. When Ramsey distinguishes isomorphs from mere causal relays, he obviously restricts the concept of isomorphism to nontrivial isomorphs that involve more than identify and difference; for example, isomorphs that preserve metric relations. Also see Gallistel, 1993, p. 27.

(p. 83), or the drawing of "inferences" (p. 79). But absent a noncircular definition of these concepts, they will provide little help in deciding whether an entity is or is not used as a representation. The problem is especially acute considering the range of cases that Ramsey discusses in representational terms—for example, a car that would negociate an S-shaped circuit by tuning the orientation of its wheels to an internal miniature shaped as an S (p. 199). By tracking the shape of the miniature, the car avoids bumping into barriers. We can even explain its success by pointing out that the internal miniature is a literal isomorph of the circuit. Contrary to Ramsey, however, the car does not seem to engage in "learning" or "reasoning" at all. At best the car may be said to engage in problem solving. But reliance on an isomorph, even a highly successful one, in solving a problem is not enough to turn this isomorph into a representation. Assume that I am facing the door of my new apartment. The landlord has given me a bunch of keys, but I do not know which one opens the door. By trying the keys one after the other, I eventually find the correct one. The key I use to open the door is *isomorphic* to the lock; I *use* this isomorph to open the door; and my *success* at opening the door is due to the isomorphism between the key and the lock. Yet my key is no more a representation than the firing pin in a gun or the shade in Ramsey's backyard are representations.

Ramsey argues that those who attribute a representational role to causal relays do so incorrectly, by analogy with examples in which causal relays are actually used as representations:

> It is plausible to assume that the receptor notion in cognitive science is derived from our use of receptor-like structures that exist in the external world. *We* use things that reliably respond to something else to make accurate inferences about various things in the world. The rising mercury in a thermometer literally informs us that the temperature is rising. (p. 218)

By ascribing a representational role to the S-shaped miniature inside the car, however, Ramsey seems to be committing the very same mistake he is arguing against in the case of causal relays. *We* use isomorphs, just as we use causal relays, to make inferences about things in the world. But the *car* is no more a user of representations than I am when I open my door with a key isomorphic to its lock.

To understand what could make a representation of an S-shaped miniature, remember that making or using a representation involves two domains, X and Y, each with its distinctive features. Now, there is no way we coud use elements of X to represent elements of Y if we knew nothing of the latter *independently of our representational use of X*. If we knew nothing about temperatures independently of thermometers, reading the latter could never "inform us that the temperature is rising." And people must have known a good deal about temperatures *before* starting to use thermometer readings as representations of the current temperature. Similarly, the person who uses the map of a terrain as a representation of angles and distances must know what angles and distances are independently of any map—otherwise there is no way the map could function as a representation. This is the essence of the quote by Nunn (1909-1910) that starts my review, and this, among other things, is what Ramsey's example of the car with the S-shaped

miniature misses. Ramsey's car never knows anything about the S-shaped circuit, even when tracing its curve perfectly. The car does not even have sensors that would allow it to know about the shape of *any* circuit. Whether the car "knows" its internal miniature is debatable, but in any event, the car cannot employ this miniature as a representation of a circuit because the car never knows anything about circuits.

What about a concept of representation such as Gallistel's (1993), in which internal isomorphs of stimulus variables mediate causal relations between environment and behavior? This alternative conception of representation fails just as Ramsey's example of the car does, although for slightly different reasons. In Gallistel's conception, animals never know anything about the environment except through internal mediators that are isomorphic to their causes. As we have seen, an animal would have to know something about the environment (Y) *independently* of its isomorphic effects (X) to use the latter as representation of the former. But this will never happen, since on Gallistel's conception the only way the animal can know about Y, if at all, is through X. An internal mediator isomorphic to its environmental causes is no more a representation than a key or a lock is, regardless of the usefulness of the isomorph or its fine tuning through natural selection (Gallistel, 1993, p. 31). Keys are functioning isomorphs and are fine tuned to the corresponding lock, but they are not representations—unless a locksmith or an artist who knows about keys *and* locks decides to use the former as representations of the latter.

Conclusion

Representation Reconsidered is a good book, and I recommend its reading to anyone interested in theoretical debates about the explanation of behavior. In particular, I hope that Ramsey's work will increase awareness of the widespread abuse of representational notions in cognitive science (Hutto, 2011). Ramsey correctly criticizes the tendency, which he calls "silly," to ascribe representation to entities as diverse as bacteria, viruses, collating copy machines, and glass vases (p. 11, p. 170, p. 177) on no more ground than linguistic license.

I do not believe, however, that Ramsey correctly identifies the minimal grounds for making a representation of an entity X. Employing X as a representation of Y implies, at the very least, knowledge of Y beyond X and independently of X (Nunn, 1909-1910). Causally and behaviorally speaking, when X is used as a representation of Y, the effects of X must depend on separate exposure to at least some of the features exemplified by Y. It is the latter that give historical grounding to the eventual effects of X on behavior (Tonneau, 2007). This minimal causal structure is absent from all the alleged cases of representation that Ramsey discusses.

Because there is no shared causal structure between actual examples of representation and the putative cases (whether conceived as causal mediators, isomorphs, or dispositions) discussed by cognitive scientists, the notion of internal representation should be rejected. Neural processes may well be *analogous*, in

some superficial respect, to some representations (cf. Gentner & Jeziorski, 1993), but the fact remains that they are not representations. Whenever behavior is explained by appealing to an internal isomorph of the environment, what does the explanatory job is the notion of isomorphism and not that of representation. Remember that these two notions are entirely distinct. As we have seen, some isomorphs, even functioning isomorphs, are not representations. Conversely, beyond the trivial isomorphism mentioned in Footnote 2, some representations are not isomorphic to what they represent (van Fraassen, 2008). Insisting on calling a neural isomorph a "representation" amounts to projecting agency and intentionality on a biological phenomenon to which they do not belong.

When applied to perception and, in particular, to consciousness, the concept of representation has had even more disastrous effects. It has convinced people that they are conscious, not of the environment itself, but of covert surrogates hidden somewhere inside the brain (Tonneau, 2011). The end result has been to turn the nature of conscious contents into an incomprehensible neurological mystery. Dennett (1995) thinks that evolution by natural selection is the "single best idea anyone has ever had" (p. 21). I have no particular candidate for humanity's best idea, but I do think I know which is the *worst* idea anyone has ever had. This idea is that of mental representation. Representation should not be reconsidered. It should be thrashed.

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