COGNITION NEEDS SYNTAX BUT NOT RULES

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Human cognition is rich, varied, and complex. In this Chapter we argue that because of the richness of human cognition (and human mental life generally), there must be a syntax of cognitive states, but because of this very richness, cognitive processes cannot be describable by exceptionless rules.

The argument for syntax, in Section 1, has to do with being able to get around in any number of possible environments in a complex world. Since nature did not know where in the world humans would find themselves—nor within pretty broad limits what the world would be like—nature had to provide them with a means of "representing" a great deal of information about any of indefinitely many locations. We see no way that this could be done except by way of syntax—that is, by a systematic way of producing new, appropriate representations *as needed*. We discuss what being systematic must amount to, and what, in consequence, syntax should mean. We hold that syntax does *not* require a part/whole relationship.

The argument for the claim that human cognitive processes cannot be described by exceptionless rules, in Section 2, appeals to the fact that there is no limit to the factors one might consider in coming to a belief or deciding what to do, and to the fact that there is no limit in principle to the *number* of factors one might consider in coming to a belief or deciding what to do.

We argue not on the basis of models in cognitive science, but instead from reflections on thought and behavior. We do not take our argument to have obvious short-term implications for cognitive science practice; we are not seeking to tell cognitive scientists what specific sorts of modeling projects they should be pursuing in the immediate future. We do think that our arguments have longer-term implications for cognitive science, however, because if we are right about human cognition then adequate models would ultimately need to somehow provide for cognitive processes that (i) are too complex and subtle to conform to programmable, exceptionless rules for manpulating mental representations, (ii) employ syntactically structured representations, and (iii) operate on these representations in a highly structure-sensitive—and thereby highly content-appropriate—ways. We also think the views put forward in this Chapter do have some significant links to certain leading ideas behind some extant models in cognitive science, especially models (connectionist, classical-computational, and hybrid) that incorporate syntactic structure and structure-sensitive processing, and/or operate via multiple soft-constraint satisfaction.

1. Syntax: The Tracking Argument

In order to survive in a complex, changing, and uncertain world, an organism must be able to keep track of enduring individuals and of their changing properties and relations. The number of potential predications of properties and relations to individuals that must be available to an organism, for it to be capable of surviving in a complex and uncertain world, is enormous—orders of magnitude too high for each to be pre-wired into the system as a simple representation without compositional structure. The needed compositional structure is syntactic structure. We call this the "tracking argument," because it involves the capacity to keep track of items in the environment. This argument will be illustrated and elaborated in what follows.

1.1. *Beliefs about One's Locale and the Tracking Capacities that Subserve Them*. When philosophers talk about beliefs, they tend to consider examples such as your belief that George W. Bush is President of the United States. We want to focus on a different, more mundane, kind of belief. At this moment you have beliefs about the locations of literally hundreds, perhaps thousands, of small to medium-size objects in your vicinity, seen and unseen. You also have beliefs about the perceptual and nonperceptual properties of many of these objects. You have beliefs about the functions or uses of many of them, beliefs about what many of them are made of, beliefs about dispositional properties of many of them, and beliefs about the ages, parts, contents, etc. of some.

Take a moment to consider the many things in your present location about which you have such beliefs. I am in an academic office. I have beliefs, to begin with, about many of the hundreds of books in the office. Of course, I am not now aware of most of these beliefs, but any one of them could come to mind if something prompted it. I believe, for example, that Russell’s *The Problems of Philosophy* is on such and such self, because I remember it being there. I believe that Wittgenstein’s *Tractatus* is in the same vicinity, not because I specifically remember it being there, but because that is where the books in the history of analytic philosophy are. I might also wonder whether a certain book is in the office, or regret that another book is at home. Thus, I have thoughts representative of many different attitudes about books in the office. I also have beliefs about the color and size of many of these books, which beliefs are put to work in looking for books on the shelves. (I also have opinions about the contents of some of these books, but we need only concern ourselves with beliefs about them as physical objects.) And, of course, I have beliefs about many other kinds of things in the office: furniture, decorations, supplies, files, etc.

Whenever you take up a new location, even for a short while, you acquire many new beliefs of this kind. Think, for example, of a campsite or hotel room, or a restaurant. On being seated in a restaurant, you quickly form numerous beliefs about the locations of typical restaurant items in this restaurant, about particular patrons, etc. You also, of course, have knowledge of the locations and properties of things in other familiar locations. Think, for example, of how much you know about items in your own kitchen. (And of course, you can quickly acquire a good deal of that same kind of information about a kitchen where you are visiting.)

So you have had an enormous number of beliefs about items in your vicinity. Such beliefs are obviously necessary to get around in the world and to make use of what the world provides. Most of the beliefs that any natural cognizer has in the course of its career are of this kind—beliefs about objects that it does or may have to deal with.

But reflect further. Nature did not know where on Earth you were going. You could have gone to different places; then you would have had different beliefs about your locale. Nature had to provide you with the capacity to take in—have beliefs about—the configuration of objects any place on Earth. But also, nature did not know exactly what Earth was going to be like. You have the capacity to take in many possible Earth-like locales that have never actually existed. You have, indeed, the capacity to take in many more possible locales that are not particularly Earth-like—witness e.g., *Star Trek*. The beliefs about your immediate environment that you are capable of having—and about potential immediate environments that you are capable of inhabiting—far outstrip the beliefs that you will ever actually have.

Of course, what we have been saying is true of every human being. And, to a significant extent, it must be true of most any cognitive system that is capable of getting around and surviving in the world. Any successful natural cognitive system must be capable of representing the situation in its locale for an indefinite number of possible locales—and representing the situation means representing a very large number of things and their numerous properties and relations.

The beliefs a cognizer forms about items in its environment must have content-appropriate causal roles—otherwise they would be of no help in survival. Thus, cognitive systems must be set up in such a way that each *potential* belief, should it occur, will have an appropriate causal role.[1]

1.2. *What is Syntax?* One might, perhaps, provide *ad hoc* for states with semantically appropriate causal roles in a simple system by wiring in all the potentially necessary states and causal relations, but that would hardly be possible for the complex cognitive systems we actually find in nature. The only way a cognitive system could have the vast supply of potential representations about the locations and properties of nearby objects that it needs is by having the capacity to *produce* the representations that are "needed" when they are needed. The system must generate beliefs from more basic content. Thus, the following must be at least approximately true: (1) For each individual *i* and property *P* that the system has a way of representing, a way of representing "that *i* has *P"* is automatically determined for that system. And the representation that *i* has P must automatically have its content-appropriate causal role. Thus, (2) whenever the system discovers a new individual, potential states predicating old properties to the new individual must automatically be determined, and when the system discovers a new property, states predicating that property to old individuals must be determined. And, again, those new states must have their content-appropriate causal roles. (1) and (2) are possible on such a vast scale only if representations that predicate different properties of the same individual are systematically related, and representations that predicate the same property of different individuals are systematically related. Then representations can be "constructed" when needed on the basis of those systematic relations. In no other way could there be the vast supply of potential representations that natural cognizers need in order to track their surroundings.

Any representational system with such relations has a syntax, and any such system is a language of thought. Syntax is simply the *systematic* and *productive* encoding of semantic relationships, understood as follows:

> *Systematic* When different representational states predicate the same property or relation to individuals, the fact that the same property or relation is predicated must be encoded within the structure of representations. And when different representational states predicate different properties or relations to the same individual, the fact that it is the same individual is encoded in the structure of representations.
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> *Productive* When a representation of a new property or relation is acquired, the representations that predicate that property of each individual must be automatically determined. When a representation for a new individual is acquired, the complex representations that predicate properties of that individual must be automatically determined.

In order for a system of syntactically structured representations to be a language of *thought,* one thing more is necessary. The representations must have semantically appropriate causal roles within a cognitive system. The causal roles of representations depend in part upon the semantic relationships of their constituents, which are encoded in syntactic structure. Thus, the fact that a representation has a particular syntactic structure must be capable of playing a causal role within the system—a causal role appropriate to the representational content that is syntactically encoded in the representation. Syntax in a language of thought must be, as we will say, *effective*.

When philosophers think of language, they tend to think of the languages of logic. In a theory formulated in the first-order predicate calculus the fact that two sentences of the theory predicate the same property of different individuals is encoded in the structure of representations by the presence of the same predicate at corresponding places in the two sentences. So a first order theory is systematic. And first order theories are productive. When a new predicate representing a new property is added to the theory, new sentences predicating that property of each individual represented in the theory are automatically determined. In logic, and in the syntax of classical cognitive science, systematicity and productivity are achieved by encoding identity of reference and identity of predication by shared *parts* of strings; syntax is realized as a part/whole relation. We will call such part/whole based syntax *classical syntax* (following Fodor and McLaughlin, 1990).

It is extremely important to understand the following point. It is by no means *necessary* that syntax—systematicity and productivity—be based on part/whole relationships. What is necessary for productivity and systematicity is this: there must be systematic formal relations between complex representations and their constituents which are used by the system in constructing complex representations. Nonclassical constituency is common in natural language. Irregular plural nouns and irregular verbs in English are examples of nonclassical syntax. It would be a mistake to think that these irregulars were syntactically simple (although perhaps semantically complex). Irregular verbs interact with auxiliaries—paradigmatically a matter of syntax—in just the way regular verbs do. "He may drank the water" is syntactically and not just (or even) semantically bad, and it is bad in just the same way as "He may poured the water." Nonclassical, non-part/whole, constituency is the norm in highly inflected languages such as Greek, Latin, and Sanskrit (and, of course, in many non-Indo-European languages). If syntax meant classical syntax (in Fodor and McLaughlin's sense), then the classical natural languages would not have syntax.

Furthermore, it is easy to make up languages with nonclassical constituents. Imagine, for example, a language in which there is one class of pure wave forms that can be used as proper names and other classes of wave forms that can be used as general terms, relational terms, adverbs, connectives, and so on. When a general term is predicated of an individual, the general-term wave form and the individual name wave form are produced simultaneously. Sentences are analogous to *chords*, not to tunes. Slight conventional modifications of the basic pure wave forms indicate that a word is a direct object, an indirect object, etc. Sound waves, like all waves, superimpose; so in the chord none of the individual waves that went to make it up is tokened.[2] If there are creatures with such a system of communication, it would hardly be reasonable to deny that they have a language, or to say that their language lacks syntax. Likewise, if a system of mental representations encodes predication in a similar manner, it would be inappropriate to deny that this system has syntax or that it is a *language* of thought. Our suspicion is that the language of thought is more like this than it is like the first- order predicate calculus or LISP. Syntax is the effective, systematic, and productive encoding of representational content, however it is accomplished.

1.3. *Complex Skills.* We first presented the tracking argument, in section 1.1, not in terms of hanging out in the world, but in terms of getting around in the world—in particular, in terms of the exercise of complex physical skills. It is important to our argument that complex physical skills have an essential, rich, and pervasive *cognitive* component that involves the capacity to represent features of the skill domain on a vast scale—so vast, again, that it requires a systematic way of constructing representations as they happen to be needed (i.e., syntax). We will take basketball as an example, but what we say about basketball can be applied, *mutatis mutandis*, to an indefinitely wide range of mundane physical activities, including hunting, gathering, housekeeping, and getting about in crowded shopping areas. One could not do any of these things without employing novel representations on a vast scale; hence, one could not do so without employing syntactically structured representations.

Hundreds of times in the course of a basketball game a player is faced with a decision that must be made very rapidly, to shoot or pass, for example, and if to pass, to which teammate. The player has to take in a complex, rapidly changing situation, and doing this no doubt takes a specialized, practiced kind of perceptual processing. What we want to call attention to here, however, is that there is a large amount to propositional, hence syntactically structured, information the player must apply to the scene to appropriately “take in” the situation.

First, there are the basic properties that structure the game, so obvious that one may overlook them. Who is in the game? Of those in the game, who is a teammate and who is an opponent? This information is *not* literally contained in a perceptual or image-like representation of the situation. There are also more global properties of the game, such as the score, the time left on the time clock, the time left in the game, the coach's game plan and/or latest instructions, and what defense the opposition is playing.

Second, there are specific properties of individual players: height, jumping ability, speed, shooting ability, and so forth. Third, there are more transient properties: who is guarding whom, what position each player is playing, who is having a good game and who isn't, who is shooting well, who is in foul trouble, etc.

All this language-like information must be related in the right way to the possibly more imagistic representation of the evolving scene. You must know *which* player you see is Jones who is on your team, in foul trouble, not a good shooter, etc. To play basketball one must predicate many nonperceptual properties to those one sees and to others one knows to be in the vicinity.

Thus, much of the information that goes into a basketball player's on-court decisions is language-like, coming in repeatable chunks. There are repeatable properties and relations that are attributed to different enduring individuals of different types—games, teams, persons, balls, etc. For a system of the size and complexity of a basketball cognizer there is no alternative to encoding identity of reference and of predication in the structure of representations themselves, so that representations can be constructed as needed on the basis of this structure. That is, what is needed is syntax.

One response we have heard to this is that skilled basketball play does not involve representations at all. What the skilled player has acquired, so this response goes, is a system that issues in behavior, not representations. This is an expression of a common view about physical skills: that they are fancy, acquired systems of dispositions to respond to stimuli. One might suppose, then, that what one acquires in basketball practice is a system mapping perceptual input to responses, in effect extrapolating from experienced situations to new situations, so that variations in responses are correlated with variations in situations, in perceptual input. But to suppose this would be to seriously misunderstand and underestimate what goes on in the exercise of physical skills.

Some players are better at recognizing situations than others. Thus, players with similar physical abilities do not always respond in physically or behaviorally similar ways to similar situations, because their cognitive abilities and responses are different. One way players improve is in their ability to recognize situations.

But there is a deeper flaw in the idea that physical skills are dispositions to respond. There is no such thing as *the* response a player would make to a specific court situation. A player can do many different things in a given situation, depending upon his current aims. A player's physical skills plus his understanding of the present court configuration are not sufficient to determine his action. Short-term strategic considerations figure importantly in determining a player's actions. The game plan for this game, the strategy currently in effect, the play called by the point guard, the time on the shot clock, the score, the time left in the game—all of these can influence what a player does. Indeed, they may all do so independently at once. None of these is a part of the court configuration, or perceived scene, or physical stimulus. Thus, there are many different responses a player might make to a given court configuration, depending upon various other considerations. The player's representation of the court configuration plus his understanding of the strategy in effect determine how he will exercise his physical skills. This would be impossible if he didn't *have* a representation of the court configuration—which, we repeat, must include attribution of various kinds of nonperceptual properties (teammate, center, etc.).

The phenomenon of shaving points is interesting here. This is something a person can do for the first time, without practicing *or learning anything new*. Shaving points and throwing games are illegal and immoral in organized sports (though they happen). It is, therefore, worth noticing that shaving points is a common and useful occurrence in social sports. Think of individual sports like tennis and golf. You do not play the same way against a player you can beat easily as you do against one who is your equal or better, but you do not give points away either. And at very modest skill levels one can play in a way that will keep the score respectable without having to keep one's mind on it. One does this differently against different players, and often one can do it without conscious thought—even the first time one faces a particular player. Suppose you were determined to beat your opponent as badly as possible by playing as well as possible. You would play differently than you would against the same opponent if you wanted to keep the score respectably close. And that means you would respond to particular stimuli in a different manner. But you would be using the same knowledge and skills to do it.

A player can play and practice basketball with many different purposes, and with each different purpose, the player's responses to certain physical stimuli will be different than they would have been given other purposes. The same system of skills and abilities would be put to use to produce any of these different responses. Thus, basketball skills (including cognitive skills) do not alone determine responses on the court. So the basketball player cannot properly be thought of as having a system that merely produces responses to stimuli. Part of what the player has is a system that generates representations that can be put to use in determining responses, either typical or atypical, depending on other factors.

Furthermore, each of these different potential responses would be *appropriate* to the current situation. They would be recognizably basketball responses, if not optimal basketball responses. It would be impossible to be capable of so many different appropriate responses to a given situation without actually representing a great deal of the situation and without being capable of representing whatever might go into helping determine one of those responses. In general, physical skills can be exercised in a variety of ways, including novel ways, depending on present goals and purposes. This would be impossible if physical skills were simply learned systems of responses to stimuli. Basketball, and all physical skills, requires the capacity to bring a large amount of non-perceptual propositional, hence syntactically structured, information to bear on the present task.

1.4. *A Remark about the* Argument. We want to distinguish the tracking argument, rehearsed in this section, from an important argument in linguistics, known as the productivity argument. It goes as follows. Every speaker knows many ways of taking a given sentence and making a longer sentence. Hence, there is no longest sentence of a natural language; that is, every natural language contains infinitely many sentences. But speakers are finite. The only way a finite speaker could have such an infinite capacity is by having a capacity to construct sentences from a finite vocabulary by a finite set of processes—i.e., by having a system of rules that generates sentences from finite vocabulary (i.e., syntax).

The tracking argument differs from productivity arguments—and from similar arguments concerning infinite linguistic capacity. These arguments appeal to recursive processes and logically complex representations. The tracking argument, however, appeals only to states of the sort that would most naturally be represented in the predicate calculus as (monadic or n-adic) *atomic* sentences, without quantifiers or connectives—that is, to representations that predicate a property of an individual or a relation to two or three individuals. Thus, the vastness of potential representations we are talking about in the tracking argument depends not upon recursive features of thought, but only upon the vastness of potential simple representations.[3]

2. No Exceptionless Rules

In Section 1 we argued that cognition requires syntax, understood as any systematic and productive way of generating representations with appropriate causal roles. The most familiar, and perhaps most natural, setting for syntactically structured representations is so-called "classical" cognitive science—which construes cognition on the model of the digital computer, as the manipulation of representation in accordance with exceptionless rules of the sort that could constitute a computer program. In this way of conceiving cognition, the rules are understood as applying to the representations themselves on the basis of their syntactic structures. Let us call these rules "programmable, representation-level rules" (PRL rules).[4]

We maintain that human cognition is too rich and varied to be described by PRL rules. Hence, we hold that the classical, rules and representations, paradigm in cognitive science is ultimately not a correct model of human cognition. In this section we briefly present two closely related kinds of considerations that lead us to reject PRL rules. First, there is no limit to the exceptions that can be found to useful generalizations about human thought and behavior. Second, there is no limit to the *number* of considerations that one might bring to bear in belief formation or decision making. Since any PRL rules that might be proposed to characterize, explain, or predict some kind of human behavior would essentially impose a limit on relevant factors and on possible exceptions, such rules would go contrary to the limitless scope, in actual human cognition, of potential exceptions and potentially relevant considerations.

2.1. *Basketball, again*. These features of cognition are apparent in the basketball example. Players play differently in the same circumstances depending on their present aims and purposes, broadly speaking. As we said above, one's immediate purposes are influenced by factors such as game plan, score, time, and so forth. How one responds to a situation can also change when one goes to a new team, when the team gets a new coach, when one is injured, etc. We will mention two descriptions of factors that can influence how one plays in certain circumstances. Each of these descriptions in fact covers indefinitely many possible influencing factors of that type. First, one can attempt to play the role of a player on an upcoming opponent's team for the sake of team practice. Clearly, there are indefinitely many possible opponents one could attempt to imitate. Second, one's play may be influenced by one's knowledge of the health conditions of players in the game. Making such adjustments is fairly natural for human beings. But there is no way that a system based on PRL rules could do it with the open-ended range that humans seem to have; rather, the PRL rules would have to pre-specify—and thereby limit—what counts as a suitable way to mimic a player on another team, or what informational factors about opposing players can influence how one plays against them.

2.2. *Ceteris Paribus*. Imagine being at someone's house at a gathering to discuss some particular topic, a philosophical issue, say, or the policy or actions of an organization. And imagine that you are very thirsty and know that refreshments have been provided in the kitchen. There is a widely accepted generalization concerning human action that is certainly at least approximately true:

> (A) If a person *S* wants something *W*, and believes that she can get *W* by doing *A*, then (other things equal) she will do *A*.

In the case at hand, if you want something to drink, and believe you can get something to drink in the kitchen, you will go to the kitchen. Neither (A) nor its typical instances are exceptionless, however—which is signaled by the parenthetical "other things equal." You might not go to the kitchen because you do not want to offend the person speaking; or you might not want to miss this particular bit of the conversation; or you might be new to the group and not know what expected etiquette is about such things; or there might be someone in the kitchen who you do not want to talk to. One could go on and on. And so far we have only mentioned factors that are more or less internal to the situation. You would also not go to the kitchen if, say, the house caught on fire.

Generalizations such as (A) are frequently called *ceteris paribus* (all else equal) generalizations. Some have suggested that they should be named "*impedimentus absentus* generalizations." Given your thirst, you will go to the kitchen *in the absence of impediments*. (The impediments can, of course, include your other beliefs and desires). One thing that is important to see is that (A) is a generalization of a different logical form from the familiar universal generalizations of categorical logic and the predicate calculus. It is not like "All dogs have four legs," which is falsified by a single three-legged dog. It is like "Dogs have four legs." This is not falsified by dogs with more or less than four legs, provided the exceptions have explanations.[5]

Thus, (A) or something very like it is true; exceptions are permitted by the "other things equal" clause. The point we are emphasizing is that there is no end to the list of acceptable exceptions to typical instances of (A) such as the one about you going to the kitchen. One could, indeed, go on and on listing possible exceptions. Furthermore, the example we have used is just one of an indefinitely large number that we could have used. PRL rules are not the kinds of generalizations that apply to this aspect of human cognition. PRL rules cannot allow endless possible exceptions.

Finally, it bears emphasis that instances of (A) can be used to explain and predict human behavior. Very often it is possible to know that all *ceteris* is *paribus*.[6]

2.3. *Multiple Simultaneous Soft Constraints*. Think of ordering dinner in a restaurant. What you order is influenced by what kind of food you like, by how hungry you are, by the mood you are in, and perhaps by price. But what you order can be influenced by many other factors: what others in your party are ordering, what you had for lunch, what you expect to have later in the week, whether you have been to this restaurant before and what you thought of it, whether you think you might return to this restaurant. Again, we could go on and on.

There is no limit to the factors that could influence what you order. Each factor is a "constraint," pushing for some decisions and against others. But (typically) each of the constraints is "soft"—any one of them might be violated in the face of the others. The phenomenon of multiple, simultaneous, soft constraints seems to be ubiquitous in cognition. It is typical of "central processes": deciding, problem solving, and belief fixation.[7] (The classic detective story is a paradigm case in the realm of belief fixation, with multiple suspects and multiple defeasible clues.) In such cases one is often conscious of the factors one is considering—though often one is not aware of how they conspired to lead to the final decision. If there are too many factors to keep in mind and the matter is important enough, one may recycle the factors mentally or write them down. Imagine deciding what job to take (supposing you are fortunate enough to have a choice), or what car to buy, for example. But in other kinds of cases, such as social situations, physical emergencies, and playing basketball, multiple simultaneous soft-constraint satisfaction appears to occur quite rapidly (and often unconsciously).

In many instances, multiple simultaneous soft constraint satisfaction permits indefinitely many factors to be influential at once—and generates outcomes that are appropriate the specific mix of indefinitely many factors, however numerous and varied and heterogeneous they might be. Exceptionless rules cannot take account of indefinitely many heterogenenous factors and the indefinitely many ways they can combine to render some specific outcome most appropriate, because such rules would have to pre-specify—and thereby limit—all the potentially relevant factors and all the ways they might jointly render a particular outcome the overall most appropriate one.

3. Concluding remarks

We have argued that complex cognition must utilize representations with syntactic structure because that is the only way for there to be the vast supply of representations that cognition requires. But we have also argued that many of the processes these representations undergo are too rich and flexible to be describable by exceptionless rules.

The heart of classical modeling is programs, hence exceptionless rules. Many connectionist models, on the other hand—and more generally, many dynamical systems models—do not employ syntax. We have no quarrel with, and in fact applaud, both (i) models in the classical rules and representation mode, and (ii) connectionist and dynamical-systems models that do not involve syntax. But if the arguments of this chapter are right, then neither kind of model can be expected to scale up well from handling simplified “toy problems” to handling the kinds of complex real-life cognitive tasks that are routinely encountered by human beings. Scaling up will require forms of multiple soft-constraint satisfaction that somehow incorporate effective syntax (as do many extant classical models), while also eschewing the presupposition of PRL rules (as do many extant connectionist and dynamical-systems models, in which rules operate only locally and sub-representationally whereas representations are highly distributed).[8]

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[1] For any given belief, causal role is a complicated matter. If I believe there is a coffee cup just out

of my sight on the table to my left, this may influence my behavior in many different ways. If I want some coffee, I may reach out, pick up the cup, and sip from it. (Note that I may well not have to look at the cup.) If I want to take my time answering a question, I may pick up the cup, bring it to my lips, pause, and put it down again. If I want to create a distraction, I might “inadvertently” knock over the cup. And so forth.

[2] Connectionist tensor product representations are relevantly similar to the chord language. Cf. Horgan and Tienson 1992, 1996 pp. 74-81.

[3] Thus, we believe, the argument applies not only to human cognition but also to nonhuman animals, for whom it is difficult to find evidence for more than a minimum of recursive structure in representations. Birds and mammals have languages of thought.

[4] It is important that these rules are supposed to be stateable at the level of the representations themselves. Although processing may also conform to rules stateable at lower levels (e.g., the level of machine language in a conventional computer), such lower-level rules are not the kind that count. There can be (nonclassical) systems that conform to rules at lower levels but do not conform to rules stateable solely in terms of representations.

[5] It is probably not a good idea to call such generalizations *impedimentus absentus* generalizations, since one important class of such generalizations is simple moral principles: lying is wrong, stealing is wrong, etc, which have exceptions that are not *impediments*.

[6] For more on this theme, see Horgan and Tienson 1990, 1996 ch. 7.

[7] Jerry Fodor (1983, 2001) has compared belief fixation to theory confirmation in science. Theory confirmation is “holistic”; the factors that might be relevant to the confirmation (or disconfirmation) of a particular theory may come from any part of science. (This, he suggests, is why confirmation theory is so underdeveloped compared to deductive logic. Deductive validity is a

strictly local matter, determined by nothing but the premises and conclusion of the argument.) Likewise, anything one believes might turn out, under some circumstances, to be relevant to anything else you should believe—the potential relevance of anything to anything. And there are no general principles for determining in advance what might be relevant.

[8] For a book-length articulation of one way of filling in some details of this sketch of a conception of human cognition, see Horgan and Tienson 1996.