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INFORMATION WITHOUT TRUTH

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Abstract: According to the Veridicality Thesis, information requires truth. On this view, smoke carries information about there being a fire only if there is a fire, the proposition that the earth has two moons carries information about the earth having two moons only if the earth has two moons, and so on. We reject this Veridicality Thesis. We argue that the main notions of information used in cognitive science and computer science allow A to have information about the obtaining of p even when p is false.

Keywords: semantic information, false information, Veridicality Thesis, cognitive science, knowledge.

1. Information and the Veridicality Thesis

According to the Veridicality Thesis, information requires truth. More precisely, our main focus is the thesis that if system A has information about the obtaining of p , then p .¹ On this view, smoke carries information about there being a fire only if there is a fire, the proposition that the earth has two moons carries information about the earth having two moons only if the earth has two moons, and so on. We reject this Veridicality Thesis. We will argue that the main notions of information used in cognitive science and computer science allow A to have information about the obtaining of p even when p is false.

Our rejection of the Veridicality Thesis is part of our effort to explicate the views that (i) cognition involves information processing and (ii) computing systems process information. Disentangling various threads in these views, which are ubiquitous in cognitive science and computer science, is part of a broader investigation into the foundations of cognitive science (Piccinini and Scarantino forthcoming). The take-home message of this essay is that a healthy pluralism in the theory of

¹ By “system A has information about the obtaining of p ” we mean that information about the obtaining of some p is available to system A . We are neutral on whether A is in a position to interpret, and make use of, the information available to it. This formulation of the Veridicality Thesis is provisional: we will later distinguish between two versions of the Veridicality Thesis, one for “natural” and the other for “nonnatural” information.

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information leads to positing kinds of information that are at odds with the Veridicality Thesis.

2. Information as a Mongrel Concept

Accounts of information can be motivated by either of two assumptions. The first is that the disparate uses of the term “information” in ordinary language and science can be captured by a unique, all-encompassing notion of information. The second is that different uses of “information” reveal a plurality of notions of information, each in need of a separate account. We endorse this second assumption: information is a mongrel concept in need of disambiguation.

The allure of the Veridicality Thesis may be due at least in part to a lack of distinction between two notions of *semantic* information. Generally speaking, semantic information has to do with the semantic content, or meaning, of signals.² There are at least two important kinds of *meaning*, namely, natural and nonnatural meaning (Grice 1957). Natural meaning is exemplified by a sentence such as “Those spots mean measles,” which is true—Grice claimed—just in case the patient has measles. Nonnatural meaning is exemplified by a sentence such as “Those three rings on the bell (of the bus) mean that the bus is full” (1957, 85), which is true even if the bus is not full.

In an earlier essay, we extended the distinction between Grice’s two types of *meaning* to a distinction between two types of *semantic information*: *natural information* and *nonnatural information* (Piccinini and Scarantino forthcoming). Spots carry natural information about measles by virtue of a reliable physical correlation between measles and spots.³ By contrast, the three rings on the bell of the bus carry nonnatural information about the bus being full by virtue of a convention.⁴ The two notions of information are importantly different, so the discussion on whether information entails truth needs to reflect both. Although other authors are not always clear on the distinction between natural and nonnatural information, natural information is close to the notion most often discussed by philosophers (Dretske 1981, 1988; Fodor 1990; Millikan 2004; Cohen and Meskin 2006, 2008; see also Stampe 1975, 1977).

² Notions of semantic information contrast with notions of nonsemantic information such as the one developed by Shannon (1948) for engineering purposes. What interested Shannon was not the meaning of signals but rather their probability of being selected.

³ The notion of *natural information* is similar to what Floridi (2008) calls *environmental information*. Unlike Floridi, we follow Dretske (1981) in considering *natural/environmental information* a semantic notion, despite the absence of an intelligent producer of the signals.

⁴ This is not to say that conventions are the only possible source of nonnatural meaning. For further discussion, see Grice 1957.

At this point, a critic may interject that the notion of nonnatural information is problematic, because it presupposes intentional content (say, the content *that the bus is full*). Because of this, nonnatural information cannot be used to naturalize intentionality, which is one of the central projects that have attracted philosophers to information in the first place (Dretske 1981, 1988; Millikan 2004). Hence, several authors working within this tradition have been adamant in wanting to distinguish information, understood along the lines of Grice's natural meaning, from meaning, understood along the lines of Grice's nonnatural meaning.

We agree that nonnatural information is in need of naturalistic explication just as much as intentional content. "To carry nonnatural information about" and "to represent" are (for present purposes) synonymous expressions, and representation is precisely what a naturalistic theory of intentionality aims to explicate. But our present goal is not to naturalize intentionality. Rather, it is to understand the central role played by information in the sciences of mind and in computer science.

If cognitive scientists and computer scientists used "information" only to mean natural information, we would happily follow the tradition, and speak of information exclusively in its natural sense. The problem is that the notion of information as used in the special sciences often presupposes intentional content.

Instead of distinguishing sharply between information and meaning, we distinguish between natural information, understood (roughly) along the lines of Grice's natural meaning,⁵ and nonnatural information, understood along the lines of Grice's nonnatural meaning. We lose no conceptual distinction, while we gain an accurate description of how the concept of information is used in the sciences of mind and in computer science. We take this to be a good bargain.

One payoff of our taxonomy is that we explicitly distinguish between a notion of information that can help naturalize intentionality (natural information) and a notion of information that itself needs to be naturalized (nonnatural information). Another payoff is that we minimize the risk of cross-purpose talk, which often occurs when different theorists speak of information while meaning importantly different things by it. We hope that, once the options are clear, theorists will make explicit which notion of information they are committed to.

We will now argue against the Veridicality Thesis, discussing the cases of natural information and nonnatural information in turn.

⁵ One important difference is that, unlike Grice, we reject the Veridicality Thesis for natural information, at least in the formulation we consider in section 3.

3. Natural Information Without Truth

Can spots carry natural information about measles in the absence of measles? Can smoke carry natural information about fire when there is no fire? Can a ringing doorbell carry natural information about someone being at the door even if no one is? According to Grice (1957), the answer to these questions would seem to be no. These are all cases of natural meaning, which is supposed to differ from nonnatural meaning precisely because it is truth entailing.

We depart from this standard picture by holding that the transmission of natural information entails nothing more than the truth of a probabilistic claim. The core idea of the probabilistic theory of information one of us has developed is that signals carry natural information by changing the probability of what they are about (Scarantino unpublished). On this view, spots carry natural information about measles not because all and only patients with spots have measles but because patients with spots are more likely to have measles than patients without spots.⁶

A corollary of this view is that token signals can carry natural information about events that fail to obtain. So far we have formulated the Veridicality Thesis as the thesis that if system *A* has information about the obtaining of *p*, then *p*. This formulation obscures the distinction between natural information that *o* is *probably G* (henceforth, *probabilistic* natural information) and natural information that *o* is *G* (henceforth, *all-or-nothing* natural information). As we argue below, the distinction between the two cases is crucial to a full understanding of natural information.

To frame the issue of natural information correctly, the Veridicality Thesis should be reformulated. Following Dretske (1981), we take the relation of the natural information relation to be *events*, understood as property exemplifications at a time (cf. Kim 1976). The Veridicality Thesis for Natural Information (VT_N) is the following:

(VT_N) If a signal *s* being *F* carries natural information about an object *o* being *G*, then *o* is *G*.

A corollary of VT_N is that if an agent *A* has natural information about an object *o* being in state *G* when she receives a signal *s* in state *F*, then *o* is *G*. By contrast, here is the Probability Raising Thesis for Natural Information (PRT_N):

⁶ In Piccinini and Scarantino forthcoming, we describe natural information as truth entailing, suggesting that our distinction between natural and nonnatural information parallels Grice's (1957) distinction between natural and nonnatural meaning. It should now be clear that our distinction differs from Grice's in one important respect. On our view, there is nothing objectionable in holding that "those spots carry natural information about measles, but he doesn't have measles," provided measles is more likely given those spots than in the absence of those spots.

(PRT_N) If a signal s being F carries natural information about an object o being G , then $P(o \text{ is } G | s \text{ is } F) > P(o \text{ is } G | \sim (s \text{ is } F))$.⁷

On this view, a signal s in state F can carry natural information about an object o being G simply by raising the probability that o is G , whether or not o is in fact G . We reject VT_N in favor of PRT_N.

Several contemporary theories of natural information are committed to VT_N. For instance, Cohen and Meskin argue that s being F carries information about o being G if and only if the counterfactual conditional “if o were not G , then s would not have been F ” is nonvacuously true (2006, 335).⁸ In other words, in order for smoke to carry natural information about fire, it must be that, had fire not occurred, smoke would not have occurred. From this it follows that if smoke carries natural information about the obtaining of a fire, a fire has to obtain. Thus, Cohen and Meskin’s (2006) theory entails VT_N.⁹

The notion of natural information presupposed by VT_N is all-or-nothing: either a signal carries *the* natural information *that* o is G , or it carries *no* natural information about o being G . Theorists of natural information have focused mainly on all-or-nothing natural information. This is due to their interest in a theory of information as a chapter in a theory of knowledge. For instance, Dretske argues that “[i]nformation is what is capable of yielding knowledge, and since knowledge requires truth, information requires it also” (1981, 45). This link between information and knowledge is a primary motivation for the idea that information entails truth.

The goal of an information-based account of knowledge has led many to neglect cases of probabilistic natural information that do not yield knowledge, yet fully qualify as information. In other words, the true thesis that information is *capable* of yielding knowledge gets confusedly mixed with the false thesis that information yields knowledge *in all cases*.

We maintain that, contrary to VT_N, a signal s being F can carry natural information about an object o being G even when o is *not* G . This is a consequence of PRT_N, which we endorse: if a signal s being F carries natural information about o being G , the probability of o being G must be higher given the signal than without the signal, but it need *not* be the case that o is G .

⁷ One of us has argued that signal s being F can also carry (negative) natural information about o being G by lowering the probability that o is G (Scarantino unpublished). We disregard this complication in what follows.

⁸ In the absence of the nonvacuity proviso, anything would carry information about o being G whenever it is necessary that o is G . In such a case, “if o were not G then s would not be F ” would have an impossible antecedent, and counterpossibles are commonly assumed to be vacuously true (Lewis 1973).

⁹ For a broader critique of counterfactual theories of information, see Scarantino 2008 and Demir 2008. For a response, see Cohen and Meskin 2008.

The core idea of a probabilistic theory of information is that signals carry natural information about anything they reliably correlate with. Reliable correlations are the sorts of correlations information users can count on to hold in some range of future and counterfactual circumstances. For instance, spots reliably correlate with measles, smoke reliably correlates with fire, and ringing doorbells reliably correlate with people at the door. It is by virtue of these correlations that one can dependably infer measles from spots, fire from smoke, and visitors from ringing doorbells.

Yet correlations are rarely perfect. Spots are occasionally produced by mumps, smoke is occasionally produced by smoke machines, and doorbell rings are occasionally produced by naughty kids who immediately run away. It follows that these paradigmatic signals do not guarantee the occurrence of, respectively, *measles*, *fire*, and *visitors*. They simply make such occurrences significantly more likely.

Consider the signal that the doorbell is ringing. In order for the ringing doorbell to carry the natural information that a visitor is at the door, a visitor must be at the door. This seems right. But it does not follow that a ringing doorbell carries *no* natural information about there being a visitor at the door in the absence of a visitor at the door. If the ringing doorbell is a standard one in standard conditions, it carries the natural information that a visitor is *probably* at the door. It is on account of this information, the only natural information a standard doorbell manages to carry about visitors, that we reach for the door and open it.¹⁰

Unlike all-or-nothing information, probabilistic natural information comes in degrees. For instance, if *o* being *G* is much more probable given the signal constituted by *s* being *F* than it would have been without the signal, *s* being *F* carries *a lot* of probabilistic natural information about *o* being *G*. If, instead, the probability of *o* being *G* increases only marginally given the signal, *s* being *F* carries a *limited amount* of probabilistic natural information about *o* being *G*.¹¹

¹⁰ Dretske (1981) suggests that not everything that could in principle make a signal equivocal *counts* as making the signal equivocal. Many background conditions (e.g., the integrity of the wires in a doorbell) can simply be assumed to be stable, and will qualify as “channel conditions.” Even granting for the sake of argument Dretske’s notion of “channel conditions,” there appear to be innumerable nonchannel conditions that make most signals of practical interest equivocal (e.g., naughty kids ringing doorbells).

¹¹ Even though Dretske’s (1981) theory of information focuses exclusively on all-or-nothing information, Dretske was not oblivious to the fact that natural information can come in degrees. He wrote that “[i]nformation about *s* comes in degrees. But the information that *s* is *F* does not come in degrees. It is an all or nothing affair” (Dretske 1981, 108). Thus, although Dretske’s emphasis on all-or-nothing information may appear to commit him to the Veridicality Thesis for Natural Information (VT_N), he actually endorsed only the weaker thesis that if a signal *s* being in state *F* carries *the* information that *o* is *G*, then *o* is *G*. We too endorse this weaker thesis. In summary, we think that *o* must be *G* in order for a signal to carry the natural information that *o* is *G*, but that *o* need not be *G* in order for a signal to carry natural information *about* *o* being *G*.

If someone wants to reduce knowledge that o is G to the information-caused belief that o is G , the limiting case of all-or-nothing information becomes central. But an account of information need not be built solely to provide a naturalistic foundation to knowledge. It may also be built to provide a naturalistic foundation for the explanation of cognition and behavior—the kind of explanation sought by current cognitive science.

What explains cognition and behavior is, more often than not, probabilistic information. Organisms survive and reproduce by tuning themselves to reliable but imperfect correlations between internal variables and environmental stimuli, and between environmental stimuli and threats and opportunities. In comes the sound of a predator, out comes running. In comes the redness of a ripe apple, out comes approaching.

The sorts of correlations on which behaviors are based commonly include some uncorrelated token events along the way—the more uncorrelated token events there are, the weaker the correlation. Organisms do make mistakes, after all. Some mistakes are due precisely to the reception of probabilistic information about events that fail to obtain. For instance, sometimes nonpredators are mistaken for predators because they sound like predators; or predators are mistaken for nonpredators because they look like nonpredators.

The key point is that an event's failure to obtain is compatible with the reception of natural information about its obtaining, just like the claim that the probability that o is G is high is compatible with the claim that o is not G . No valid inference rule takes us from claims about the transmission of probabilistic information to claims about how things turn out to be.

Thus, contrary to VT_N but consistently with PRT_N , a signal s being in state F can carry natural information about an object o being G even though o is not G . It follows that an agent A can have natural information about o being G whether or not o is G , provided a reliable correlation exists between the signal type received by A and the event type instantiated by o being G .

4. Nonnatural Information: The Case for the Veridicality Thesis

Talk of false information applies primarily to what we have called nonnatural information. In Grice's (1957) example, three rings on the bell of the bus carry nonnatural information about the bus being full. Suppose now that a distracted driver rings the bell of the bus three times when the bus is almost empty. In such a case, we would ordinarily speak of the three rings giving false (nonnatural) information about the fullness of the bus.

Similarly, if someone during a card game tells you that your opponent has an ace when he does not, we would ordinarily say that you have received false (nonnatural) information. We would also speak of false

(nonnatural) information when a map places a hidden treasure in the wrong location. Advocates of the Veridicality Thesis recognize that people often speak of false information. But they offer a deflationary interpretation of these habits of language, concluding that, on reflection, so-called false information is not *really* information. As a consequence, they defend the Veridicality Thesis for Nonnatural Information (VT_{NN}):

(VT_{NN}) If a signal s being F carries nonnatural information that p , then p .¹²

A corollary of VT_{NN} is that if an agent A has nonnatural information that p when she receives a signal s in state F , then p . We reject VT_{NN}, and will argue instead that an agent A may have nonnatural information according to which p (e.g., the bus is full, your opponent has an ace, the treasure is in such and such a place) even though p is false.

The most articulate defense of VT_{NN} has been offered by Floridi (2005, 2007), who gives two main arguments in support of the thesis that false “nonnatural information” is not really information: the *argument from splitting* and the *argument from semantic loss*. We consider them in turn.

Floridi expands on an analogy originally offered by Dretske, who wrote that “*false* information and *mis*-information are not kinds of information—any more than decoy ducks and rubber ducks are kinds of ducks” (Dretske 1981, 45).¹³ When we say that x is a false duck, or a false policeman, in effect we are saying that x is *not* a duck, or x is *not* a policeman. By analogy, when we say that x is false information, we might be saying that x is *not* information.

Of course, another interpretation is available. False information may be analogous to false propositions, impressions, and testimonies. As Floridi acknowledges, when we say of x that it is a false proposition, we do not mean that x is *not* a proposition. Similarly, when we say that something is a false impression or a false testimony, we do not mean that they are, respectively, *not* an impression and *not* a testimony.

So why should we conclude that “false information” works like “false duck” and “false policeman,” rather than like “false proposition” and “false testimony”? Floridi suggests that “false” is used *attributively* in “false duck” and *predicatively* in “false proposition” (cf. Geach 1956),

¹² In the case of nonnatural information, the distinction between information that o is G and information that o is probably G makes no difference for our purposes, so we will work with an unspecified proposition p from here on. Whereas we have supported the thesis that a signal can carry *natural information* that o is G only if o is G (see footnote 11), we will now reject this thesis for *nonnatural information*.

¹³ In this passage, Dretske is only referring to information in the “nuclear sense,” which by definition entails truth. He adds that he is “quite prepared to admit that there are uses of the term ‘information’ that do not correspond to what I have called its nuclear sense” (1981, 45). Our work is in part an exploration of these other uses.

and that this explains why a false duck is not a duck whereas a false proposition is still a proposition.

Floridi (2005, 364–65) distinguishes between attributive and predicative uses of adjectives through a *splitting test*. When an adjective is used predicatively, as “male” in “male policeman,” the compound can be split: a male policeman is both a male *tout court* and a policeman. When an adjective is used attributively, as “good” in “good policeman,” the compound cannot be split: a good policeman is not both good *tout court* and a policeman, as bad people who are good policemen show.

Now consider a false proposition p —for example, that the earth has two moons. Floridi argues that it passes the splitting test: p is false, and p is a proposition. This being the case, “false” is used predicatively in “false proposition.” Floridi suggests that, on the contrary, “false” is used attributively in “false information,” because “false information” fails the splitting test: “[I]t is not the case . . . that p constitutes information about the number of natural satellites orbiting around the earth *and* is also a falsehood” (2005, 365).

This argument from splitting is supposed to support the thesis that false information is not really information. But it requires the brute intuition that *that the earth has two moons* is not information. The content of this intuition is nothing but an instance of the general thesis to be established. Thus, the argument is question-begging. No independent reason to reject instances of false information as information is given. Whether false information passes the splitting test depends on whether we accept that a false p can constitute nonnatural information. We do! And so, we submit, do most other people, including most cognitive scientists and computer scientists. As far as we are concerned, *that the earth has two moons* is both nonnatural information and false.

Floridi (2007, 39–40) offers a second argument against false information. He argues that information may be lost “by semantic means.” To begin with, consider two uncontroversial cases of information loss by *nonsemantic* means. Suppose a chemistry manuscript were burned: the information contained in the manuscript would be lost “by physical means.” Or suppose that all the letters contained in the manuscript were randomly recombined: the information contained in the book would be lost “by syntactic means.”

Suppose now that all true propositions in a chemistry manuscript were transformed into their negations. For instance, the book now contains sentences like “Gold’s atomic number is not 79,” “Water is not H_2O ,” and so on. Floridi maintains that the information originally contained in the book would be lost “by semantic means.” But if false information—say, the information that water is not H_2O —also counted as information, Floridi thinks we would have to conclude that no information is lost.

The conclusion does not follow, however, unless we accept an unduly restrictive notion of information loss. To see why, we need to disambig-

uate the expression “loss of information,” which can mean at least three different things. Floridi construes “loss of information” in terms of the depletion of the total amount of information contained in an information repository, such as a manuscript. Call this the *quantitative* reading of “loss of information.” On this construal, if all the manuscript’s true propositions are transformed into false propositions, and VT_{NN} is rejected, there is no loss of information, because the total amount of information does not change. (Following Floridi, we are assuming that the amount of true information carried by a true proposition is equal to the amount of false information carried by its negation.) In other words, if we hold that false propositions carry information and that a certain number of propositions carrying true information are replaced by an equal number of propositions carrying false information, we must conclude that the total amount of information in the repository stays the same. But, *pace* Floridi, there is nothing objectionable in this conclusion.

When we worry about information loss, we are not primarily—if at all—concerned with the *quantity* of information contained in a repository. Rather, we are generally concerned with whether an information repository carries the *same* information it originally carried. If it does not, we may also be concerned with whether the *new* information that has been gained has the same *epistemic value* as the original information. The focus here is not on the total *amount* of information in a repository but on the specific information carried by the vehicles contained in the repository: any change of information content can produce information loss, whether or not the total quantity of information remains the same.

Under a *qualitative* reading, “an information repository loses information” means that after a specific operation on it, the information-carrying vehicles in the repository no longer carry the *same* information they used to carry. Presumably, a proposition and its negation are different pieces of information. Thus, by negating a proposition, we destroy the information it carries. If we reject VT_{NN} , we can say that after negating a proposition, we now have some new information instead of the original information. But we can also say, without inconsistency, that we have lost the original information—the information carried by the original proposition.

Notice that a quantitative reading of “loss of information” fails to account for this important notion of information loss. For example, suppose that every true proposition in a chemistry manuscript were to be replaced by a *true* proposition taken from a biology manuscript, and let’s assume that the amount of information carried by the pertinent chemical and biological truths is the same. In this case, there would be major information loss in the qualitative sense—the sense that matters to us in most practical contexts—even though the total quantity of information would remain just the same.

Finally, under an *epistemic-value* reading, “an information repository loses information” means that after a specific operation on it, the information-carrying vehicles in the repository carry information with a lower epistemic value. Obviously, in this sense there can be information loss even if we reject VT_{NN} . Since false information is epistemically inferior to true information, negating true propositions is a way to incur information loss by semantic means.

Summing up, rejecting VT_{NN} is compatible with accounting for information loss “by semantic means” in the two senses—the qualitative and epistemic-value senses—that matter most for epistemic purposes. Moreover, our distinctions allow us to neatly distinguish between physical and syntactic information loss on the one hand and semantic information loss on the other. In the first two cases, information is destroyed but not replaced with any new nonnatural information. There is information loss in the quantitative sense, in the qualitative sense, and in the epistemic-value sense. In the third case, information is destroyed and replaced with new (false, and thus epistemically inferior) nonnatural information. There is information loss in the qualitative sense and in the epistemic-value sense, though not in the quantitative sense.

5. Nonnatural Information Without Truth

Our main reason to maintain that nonnatural *false* information is information too mirrors our reason to posit nonnatural information in the first place: it allows us to capture important uses of the term “information.” It is only by tracking such disparate uses that we can make sense of the central role information plays in the descriptive and explanatory activities of cognitive scientists and computer scientists, which partially overlap with the descriptive and explanatory activities of ordinary folk.

As we did for natural information, we are trying to understand the kinds of information that are actually invoked in the explanation of cognition and behavior. In the case of *natural information*, the need to capture the explanatory power of the notion of information requires positing the notion of *probabilistic information*. In the case of *nonnatural information*, the need to capture the explanatory power of the notion of information requires positing *false* information and *non-truth-evaluable* information.

5.1. False Information

Cognitive scientists routinely say that cognition involves the processing of information. Sometimes they mean that cognition involves the processing of natural information. At other times, they mean that cognition involves the processing of nonnatural information, without any commitment as to

whether the information is true or false. For instance, a recent study on how aging affects belief found that “[o]lder adults were more likely than young adults to believe false information and their dispositional ratings were reliably biased by the valence of false information” (Chen 2002, 217). Statements to the effect that nonnatural information can be false are widespread in many sciences of mind.

If we accept VT_{NN} , we should endorse an *error theory* to make sense of this way of talking. According to such a theory, cognitive scientists are mistaken about the nature of cognition. Since false nonnatural information is not *really* information (as per VT_{NN}), the view that cognition involves information processing is at best incomplete. It should be supplemented by the view that, unbeknownst to most cognitive scientists, cognition also involves the processing of *misinformation*, where misinformation is understood as different in kind from information. This error theory of cognitive science is uncharitable, awkward, and unnecessary.

The notion of nonnatural information used in cognitive science is best interpreted as the notion of *representation*, where a representation is by definition something that can get things wrong. The sentence “Water is not H_2O ” gets things wrong with respect to the chemical composition of water, but it does not fail to represent that water is not H_2O . By the same token, the sentence “Water is not H_2O ” contains false nonnatural information to the effect that water is not H_2O .

One of the central challenges for a theory of cognition and behavior is to explain how a system can acquire the ability to represent, or nonnaturally mean, or carry nonnatural information, that p whether or not p is true. There is a large literature devoted to explaining how this works. Our present objective is not to explain how representation works or whether representation can be naturalized using the notion of natural information. Our objective is simply to capture existing usage and distinguish the commitments pertaining to different notions of information. Nonnatural information as used in cognitive science has the capacity to get things wrong, so it can be false.

Computer scientists are another group of scientists who refer to nonnatural information independently of whether it is true. Computer scientists routinely label as information processing all the cases in which computers process semantically evaluable structures, whether they are true or false. If we accept VT_{NN} , we should conclude that computer scientists are also mistaken: computers are more than information processors—they are misinformation processors as well. But again, this *error theory* of computer science is uncharitable, awkward, and unnecessary. It is clear that computer scientists include both true and false information under the rubric of (nonnatural) information. This is yet another reason to conclude that false information is information too.

Thus, contrary to VT_{NN} , a signal s being in state F can carry nonnatural information that p even though p is false. It follows that an agent A can have nonnatural information that p whether or not p .¹⁴

5.2. *Non-Truth-Evaluable Information*

We have so far focused on declarative nonnatural information, the sort of information paradigmatically associated with declarative sentences. Declarative nonnatural information is truth-evaluable—it may be either true or false. We have argued that false declarative nonnatural information is information too. There are also forms of nonnatural information to which the very categories of truth and falsity do not apply.¹⁵

Tracking the uses of “information” in cognitive science and computer science demands considering forms of nonnatural information that are not truth-evaluable. Consider giving people information on what to do. If you tell us to buckle up, you give us information. You inform us on what to do. But what you say is not true—not because it’s false, but because it’s not truth-evaluable.

Commands are just one example of nondeclarative speech acts. Other nondeclarative speech acts include advising, admonishing, forbidding, instructing, permitting, suggesting, urging, warning, agreeing, guaranteeing, inviting, offering, promising, swearing, apologizing, condoling, congratulating, greeting, and many others. The point of such speech acts is to transfer information, but not for the purpose of describing something. Rather, the purpose of transferring nonnatural nondeclara-

¹⁴ Fetzer (2004) has also argued that nonnatural information can be false, but his arguments are problematic (see Sequoiah-Grayson 2007). Fetzer (2004, 226) objects that certain sources of information, such as blood spots, PET scans, and tree rings, may “lack a propositional or a sentential structure.” But these classes of signals can easily be given a sentential structure if we understand them as events constituted by particulars having properties (e.g., a tree having thirty-three rings constitutes an event). Also, Fetzer (2004, 225) presents sentences such as “There is life elsewhere in the universe” as counterexamples to VT_{NN} , on the grounds that the truth-value of such sentences is unknown and may never be known. But our ignorance is not evidence against VT_{NN} . Given VT_{NN} , “There is life elsewhere in the universe” is information just in case there is life elsewhere in the universe. Whether or not we know it is irrelevant. On our view, “There is life elsewhere in the universe” would be information even if we knew that there is no life elsewhere in the universe.

¹⁵ We emphasize that we are *not* accusing supporters of VT_{NN} of ignoring that nondeclarative sentences are not truth-evaluable. Floridi (2005) explicitly states that his theory of “strongly semantic information” applies only to declarative information. Moreover, his notion of “instructional information” (Floridi 2008) seems to overlap to a large extent to what we call non-truth-evaluable information. Nonetheless, non-truth-evaluable information provides further uses of “information” that do not presuppose truth. Given that both declarative and nondeclarative information are covered by the theses that cognition involves information processing and that computing systems process information, this is further evidence that VT_{NN} does not apply to “information” as used in cognitive science and computer science.

tive information may be to express a certain emotional state (“I am sorry”), to commit to doing something (“I promise”), to get someone to do something (“Buckle up”), to produce a certain state of affairs (“I pronounce you husband and wife”), and so on. Requiring nonnatural information to be true would prevent us from understanding nondeclarative speech acts as having anything to do with information transfer.

A similar point can be made with respect to the use of “information” in computer science. A core insight of modern computer science, which made possible the design of universal digital computers,¹⁶ is the equivalence of *data* and *instructions*. Computers operate on data on the basis of instructions. Both data and instructions are physically instantiated as strings of digits, which computers can manipulate. In other words, the data and instructions that computers manipulate are intrinsically the same kind of thing—they differ only in the role they play at any given time within the computer. The very same string of digits may play either the role of instruction or that of data at different times.

Computer scientists usually assign computer data a semantic interpretation—data can have semantic content. Thus data can carry information. Computer instructions are usually interpreted semantically too—they are assigned as semantic content the operations the computer performs in response to them. But instructions are neither true nor false, because they are not truth-evaluable at all. Yet, there is no intrinsic difference between instructions and data. In addition, both have semantic content. If data can carry information, so can instructions.

The existence of non-truth-evaluable information provides another plausibility argument for false information. Given that non-truth-evaluable information carried by computer instructions and nondeclarative speech acts is information, and that the information carried by true data and true declarative information is information, it’s hard to see why the information carried by false data and false declarative sentences should not be information too.

6. An Objection

At this point, a supporter of the Veridicality Thesis (VT)—which we understand from here on as the conjunction of VT_N (section 3) and VT_{NN} (section 4)—may be tempted to object as follows (cf. Sequoiah-Grayson 2007).¹⁷ Information is a mongrel concept, as are many concepts taken from ordinary language. Subjecting a theory of information to critique because it fails to capture *some* usages of “information” presupposes that

¹⁶ Roughly speaking, a computer is universal just in case it can compute any function computable by an algorithm (until it runs out of memory).

¹⁷ Sequoiah-Grayson’s (2007) objection emerges in response to some earlier critiques of the thesis that information entails truth (e.g., Devlin 1991, Fetzer 2004). See also Floridi (2005) on Fox’s (1983) and Colburn’s (2000) critiques.

a good theory of information ought to capture *all* usages. But no theory of information can achieve that objective, precisely because the concept of information is a mongrel.

According to this objection, the notions of probabilistic natural information on the one hand and false and non-truth-evaluable non-natural information on the other show only that theories of information that abide by VT are not all-encompassing. But this conclusion is trivial, so the account we have offered in this essay is not especially interesting.

The objection would be well taken if our critique were simply that there exist ordinary usages of “information” that violate VT. This alone would be fairly inconsequential. But our point is different: any theory of information interested in making sense of the central descriptive and explanatory role information plays in both the sciences of mind and computer science must give up both VT_N and VT_{NN} . This is quite significant.

We are emphatically *not* proposing that a unique theory of information is forthcoming. This is not why we find VT problematic. In fact, we have taken pains to distinguish two importantly different usages of “information,” and two importantly different versions of VT, namely, VT_N and VT_{NN} .

To make sense of natural and nonnatural information, we need different theories of information. We need a theory of the conditions under which signals carry natural information. We also need a theory of the conditions under which signals carry nonnatural information. And, ideally, we’d like a theory about how organisms manage to manufacture signals carrying nonnatural information out of (among other things) signals carrying natural information.

In other words, our rejection of VT is consistent with the pluralism we advocated in section 2. What we have argued is that “information without truth,” in the various senses we have distinguished, can help us understand the central role played by both natural and nonnatural information in the description and explanation of cognition and behavior.

What we find at odds with pluralism is precisely the idea that VT should be one of the “basic principles and requirements for *any* theory of semantic information [and] that false information fails to qualify as information at all” (Floridi 2007, 40, emphasis added). On the contrary, we have argued that there are legitimate notions of semantic, factual, epistemically oriented nonnatural information that qualify false information as genuine—though epistemically inferior—information. And we have argued that there are legitimate notions of semantic, factual, epistemically oriented natural information that qualify probabilistic information as genuine information, even though it is not the sort of natural information of which knowledge is constituted.

Finally, we are not suggesting that a theory of information should be rejected just *because* it incorporates some version of the Veridicality

Thesis. As long as there are legitimate theoretical objectives fulfilled by the theory—from the naturalization of knowledge to the solution of certain puzzles¹⁸—endorsing a truth requirement on information need not be a liability. What we do reject is that VT belongs in an illuminating account of the central role played by natural and nonnatural information in the explanation of cognition and behavior.

7. Conclusion

We have discussed whether the primary notions of information used in cognitive science and computer science, namely, natural information and nonnatural information, commit us to the thesis that information entails truth. We have argued that the thesis does not hold in its general form for either natural or nonnatural information.

Natural information can be carried by reliable but imperfect correlations. Thus, a token signal may deliver probabilistic natural information to the effect that, say, someone is at the door even if no one actually is. The transmission of natural information, we have concluded, entails nothing more than the truth of a probabilistic claim.

The notion of (declarative) nonnatural information is best understood as the notion of representation, which by definition can be false. Consequently, the sentence “The earth has two moons” carries nonnatural information just like the sentence “The earth has one moon.” At the same time, we are not saying that true and false nonnatural information are on an equal epistemic footing: true information is epistemically more valuable than false information.

Finally, we have argued that nonnatural information need not be truth-evaluable at all—the information contained in nondeclarative speech acts and computer instructions is neither true nor false, because it is not truth-evaluable.

Our main rationale for rejecting the Veridicality Thesis in the two versions we have considered is that the thesis stands in the way of our understanding of the role played by information in the descriptive and explanatory efforts of cognitive scientists and computer scientists. We have emphasized that defining a specialized notion of information that entails some version of the Veridicality Thesis may still be useful for some specific purposes. Our point is that such a specialized notion should not be understood as germane to the main notions of information used in cognitive science and computer science.

¹⁸ For instance, Floridi’s (2005) theory of information provides a solution to the so-called Bar-Hillel-Carnap Paradox. The paradox emerges if we follow Carnap and Bar-Hillel (1952) in holding that the information content of a sentence corresponds to the set of possible worlds excluded by its truth. On this assumption, contradictions have maximal information content, because they exclude all possible worlds.

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