Public Understand. Sci. **15** (2006) 301–330

Talking brains: a cognitive semantic analysis of an emerging folk neuropsychology

Paul Rodriguez

What is the influence of neuroscience on the common sense way we talk about behavior and mental experience? This article examines this influence and the diffusion of neuroscience terms as it appears in everyday language that reflects shared cultural knowledge. In an unsolicited collection of speech acts and metaphors I show that the word "brain" often substitutes for "mind" and brain states are often asserted as the cause of mental states. I also present several examples of visual depictions of the brain, including modern brain scans, which have become the basis for new cultural symbols that are identified with mental experience. Taken together, the linguistic and visual brain metaphors highlight the concrete nature of the brain in contrast to the abstract nature of the mind. This, in turn, provides a physical dimension to the way we conceptualize mental phenomena in ordinary language. Thus, a modern *folk neuropsychology* is emerging which provides an alternative, reductionist, and sometimes competing network of concepts for explaining the mind in comparison to conventional folk psychology.

1. Introduction

In the summer of 1990, US President George H.W. Bush declared the 1990s as the decade of the brain to "enhance public awareness of the benefits of brain research."[1] With the advances in brain imaging devices, more powerful microscopes, and great strides in genetics, neuroscience seemed poised to make significant progress that could address some of the most intricate mental health issues.

The decade of the brain has now come and gone. The growth in the production of brain research has indeed been tremendous, as evidenced by the average attendance at the annual Society for Neuroscience conference, which nearly doubled from the late 1980s (about 14,000/year) to current levels (about 27,000/year).[2] In the popular media, brain diseases are often presented as both a serious health issue and a point of curiosity—a former president had Alzheimer's, a famous actor has Parkinson's, a former cover girl talks with Oprah about depression. In addition to reports on research that is easily seen to be beneficial to society, there is also wide coverage on questions related to the human mind, some of which are controversial, such as differences between males and females or the measurement of

 ISSN 0963-6625 DOI: 10.1177/0963662506063923

intelligence, and some of which are less obviously so, such as the workings of memory or language.

The question then arises: *What is the impact of brain research on the common sense understanding of mind?* This is a complicated and multifaceted question that has to take into account ways of common sense understanding and what it is about the mind that is to be explained. In this article, I will consider the mind to broadly refer to various kinds of mental phenomena, such as mental functions (thinking, remembering, believing, etc.), subjective mental experience (feeling, perceiving, sensing, etc.), and intentional behavior (acting, moving, reaching, etc.). And for this notion of mind, the dominant common sense understanding in the Western world is often called *folk psychology*. Folk psychology refers to that mentalistic network of concepts, such as beliefs, desires, and intentions, that people use to explain their own, or another's, mind and behavior (for reviews, see compilations in Greenwood, 1991; Bogdan, 1991; Hannan, 1993; Christensen and Turner, 1993). For example, why does someone rob a bank? A folk psychology explanation says that it is because he desires money and that's where he believes the money is located.

Importantly, such explanations are rooted in culturally shared conceptual knowledge and expressed in ordinary everyday language. Therefore, an important place to look for gauging the impact of brain research on the common sense understanding of mind is the diffusion of neuroscience terms, images, or ideas into everyday language. Of course, it should not be expected that detailed knowledge of neuroscience theories will be reiterated, but rather the goal is to look for brain related metaphors, references, imagery, and symbols that are used for explaining behavior in non-scientific contexts.

Thus, the above question becomes: *What is the impact of brain research in everyday language of explaining mental phenomena, experience, and behavior?* I will address this question through a cognitive semantic analysis of ordinary language and cultural images, mostly taken from media in the United States, as described in the methods section below. On the basis of this analysis, I argue that the impact of neuroscience is an emerging, modern, common sense understanding about the reduction of behavior and mental phenomena (e.g. thoughts, desires, memories, feelings, etc.) to brain entities or processes. What makes this modern, in particular, is that relatively recent scientific products, such as brain imaging scans are becoming common cultural artifacts. The upshot of all this is that coexistent with folk psychology there is a modern *folk neuropsychology*.

The presence of folk neuropsychology naturally leads one to ask how it relates to folk psychology. It may turn out to be just an extension, or perhaps it could displace or eliminate folk psychology—which is essentially the philosophical position called *eliminative materialism* (Churchland, 1981). I address this issue comparing and contrasting common sense explanations of mental phenomena and behavior based on brains to those based on folk psychology. These explanations are realized in metaphorical and literal phrases, and they provide insight into how people conceptualize the relationship of mind to brain and brain to behavior. I will argue that for the most part "brain" and "mind" are used in similar ways with similar meanings, but whereas "mind" may have an aspect of subjectivity, "brain" has a concrete and physical dimension. This concreteness, especially prominent with modern brain icons and imagery, is what helps terms and ideas from neuroscience diffuse into the vernacular of common sense explanations of the mind.

The main contribution of this article is to demonstrate, through a network of samples of speech acts, the nature of folk neuropsychology and how we ascribe mental functions and mental states to brain processes and brain states in ordinary language. Much of this language is by no means consistent and entrenched among all individuals, but the concepts expressed are emerging as common knowledge and shared symbols. The main implication is that this

folk neuropsychology is a reductionist mode of explaining the mind that is well situated to fill in the gaps in folk psychology, situate blame within the brain, and engender new conceptual schemas to understand mental phenomena.

This article is organized as follows. The method of cognitive semantics will first be described and then applied to uncover the concepts that underlie metaphors and speech acts of the mind and brain. The rest of the article will build on that by analyzing a sample of brain imagery in culture, the manner and consistency in which metaphors and imagery are used, and the relevance of folk neuropsychology to other ways of explaining behavior. Finally, the method here will be compared to other studies of metaphor in the public understanding of science.

2. Sources and methods

Sources

The popular press often reports on the latest findings of neuroscience and cognitive science, and in doing so it presents metaphors and icons about brains that work their way into our shared cultural background knowledge. Clearly, popular media has an important role in the diffusion of science. Popular media, however, is often more concerned with entertainment (see e.g. Nelkin and Lindee, 1995) and progress in science and technology is often presented with metaphors that are intended to grab the reader's attention (e.g. Liakopoulos, 2002; Christidou, Dimopoulos and Koulaidis, 2004). Moreover, the public understanding of science is not simply a matter of taking up facts, but happens in the context of social orderings, lay understanding, and interpretative filters (see e.g. Wynne, 1992, 1993; Richards, 1996; Shaw, 2002; Emslie, Hunt and Watt, 2003). It has also been shown, for example, that an increase of print in media does not necessarily imply an increase in understanding or predict public opinion (Ten Eyck, 2005). Therefore, in order to focus on the everyday language related to brains, I avoided the use of popular science magazines or newspaper articles that are specifically about brain research. Instead, I have collected a variety of metaphors, speech acts, and jokes regarding mind and brain that were produced in common and casual settings. A major source of these was merely taking from personal conversations—they were not solicited and occurred in a wide range of social contexts. I have also gathered a variety of graphics, symbols, and quotations from popular media sources such as advertisements, non-scientific newspaper stories, and radio transcripts. The few samples of text from neuroscience related articles that are included do not use direct quotes from scientists, which means the text could have been a paraphrase of a scientist or the science-writer's own colorful language. Importantly, these examples are usually accompanied by others that were taken from contexts (media or personal communications) that were not about brain research. In this sense, I have tried to focus on samples of brain metaphors that are really ordinary and non-expert.

Cognitive semantics

Cognitive semantics generally refers to the analysis of meaning and inference in language that emphasizes the use of schema-based knowledge and certain kinds of imaginative devices, such as metaphors, metonymy, and conceptual integration (Lakoff and Johnson, 1999). Schemas are hierarchically organized sets of features and relations that make up concepts, physical knowledge about objects in space (image-schemas), as well as event sequences (scripts). The relationships between these kinds of knowledge and how they are

Table 1. MIND IS A CONTAINER metaphor mapping and organizing relations

	Source	Mapping	Target
Domains	CONTAINER		MIND
Properties	physical space		abstract entities
Elements	objects	→	thoughts, feelings, memories
Organizing relations	objects are located in/out of space	→	"in my mind," "on my mind"
	things move in/out of space around	→	"empty your mind," "out of my mind"

organized into categories play an important role in understanding the embodiment of concepts (Lakoff and Johnson, 1980, 1999). In fact, all these schemas are part and parcel of understanding metaphors, hence for simplicity, I will use "conceptual schemas" to more broadly refer to all of the above kinds of knowledge.

One of the major theories to come out of cognitive semantics has been the recognition that systems of thought can be organized around analogy and metaphor comprehension/production (Lakoff and Johnson, 1980, 1999). The primary constructs with respect to analogy and metaphor are two domains of knowledge, referred to as source and target, a set of mappings between items in the source and target domain, and a set of relationships in the source domain that organize the relationships in the target domain. Importantly, such mappings are not just for figurative language, but reflect a systematic organization of knowledge. For example, the metaphor that THE MIND IS A CONTANER has the domains, mappings, and entailments in Table 1. Although we do not explicitly say "my mind is a container," there are many common phrases that express relations that systematically follow. For example, if the mind is a container then thoughts are objects that can go in or out of the mind. In this sense, the source domain in this metaphor partially structures the way we conceive of the mind, the way we talk about the mind, and the way we reason about the mind.

Another device analyzed in cognitive semantics which is closely related to metaphors is metonymy (Lakoff and Johnson, 1980). Metonymy is similar to metaphors in that there is a mapping between elements, but, unlike metaphors, these are typically in one conceptual domain. Instead of organizing relations from a source to a target domain, metonymy often reflects a mapping that highlights certain features about an element. For example, the phrase "She's just a pretty face" uses the metonymic link A FACE STANDS FOR A PERSON, and also expresses the importance of faces in person to person contact. In fact, this reference is an instantiation of a more general metonymy, of which there are many, that THE BODY PART STANDS FOR THE WHOLE PERSON (Lakoff and Johnson, 1980). Like metaphors, metonymy helps structure the way we conceive of one thing (i.e. a person) by using another thing (i.e. a face), which stands in some relation to it and highlights some feature about it.

A recent advancement in cognitive semantics is called "conceptual integration" or "blended spaces," which is a generalization of analogy and metaphors and which accounts for meaning construction in a broad range of discourse contexts, such as counterfactuals, jokes, or visual cartoons (Fauconnier and Turner, 1998, 2002; Coulson and Oakley, 2000; Rohrer, 2001, 2004). In blended space theory, the source and target domain can serve on equal footing and both contribute items and/or relationships to a mental work space (the blend) of meaning comprehension. In the blended space, new items, roles, relationships, or inferences can emerge in the act of comprehension, possibly with or without changing the way the input domains are conceived.

In this article I will not need to invoke the full suite of blended space machinery, but there are certain key ideas that will be useful. In particular, two important themes of blended space theory are identity mappings and cause–effect inferences. Identity mapping refers to the fact that two items (or two people) can be mapped onto each other for the sake of comprehension, even though it is obviously impossible. A simple example is the counterfactual that starts with: "If I were you I would . . .," and then ends with some assertion about the speaker's preferences. Because the hearer is mapped onto the speaker in a mental work space, this is also an implicit recommendation about what the hearer should do. (In fact, a common rejection is to reply "Well, you are not me . . .".) Inferences are also built into identity mappings when causes and effects are brought together into a blended space, even though the causal chain may be separated in time and space. An example is the anti-drug advertisement from the late 1980s that showed two eggs sizzling in a greasy iron skillet while a narrator says "this is your brain; this is your brain on drugs." The eggs are mapped to the brain, and greasy frying is mapping onto the effect of drugs. Although the detrimental effect of drugs is long term and occurs through a myriad of paths, the cause–effect relationship of frying eggs compresses the cause–effect of drugs into a more proximal relationship.[3] Moreover, the blended space framework recognizes the possible backward inference that eating greasy eggs is like taking drugs, and therefore detrimental to your health.

In summary, cognitive semantics provides a framework to decompose metonymic and metaphoric language into the conceptual input domains, mappings between elements, organizing relations, and systematic entailments. For complex metaphors, it also helps understand the processes involved in invoking imagery, combining visual and linguistic references, and making inferences in conceptual integration.

The psychological claim of cognitive semantics

Compared to metaphors of the mind there are relatively few obvious terms or idioms that express a common sense notion about brain functions. Most of the examples that I will present are not idiomatic expressions of entrenched metaphors, but productive applications of conceptual schemas. Of course, the singular use of a metaphor or speech act is not sufficient to deduce a speaker's representation, but it can give insight into a speaker's conceptual schema, particularly when supported by a network of examples across speakers. The psychological claim here is that such metaphor use does not determine meaning, but it is consistent with, and motivated by, active and productive underlying metaphors (for discussions of the psychology of cognitive semantics, see Lakoff and Johnson, 1980; Lakoff, 1987; Gibbs, 1994). Thus, the corpus of metaphors, jokes, images in this article, and the kinds of metonymic links, mappings, relations, or inferences they entail or promote, captures some real underlying conceptual schema when talking about brain and mind.

3. A survey of the literal and metaphorical meanings of the brain

In this section, I will organize the conceptual schemas of the brain according to literal and metaphorical meanings. I want to first, however, separate and distinguish some entrenched metaphors that are explicitly used in theories about the brain and mind, versus other metaphors that are related to folk psychology. This distinction is somewhat artificial because, as many have pointed out, scientists often start with folk theories to structure and develop operational definitions for scientific theories (e.g. Stich, 1983; Duque-Fernandez

and Johnson, 2002), and folk theories also incorporate scientific ideas. The main reasons for this artificial divide is that the scientific metaphors are somewhat conventional in both expert and non-expert language, so it is worth identifying them upfront.

Scientists, as part of theorizing, often construct analogies and metaphors to explain how the brain and/or mind work. Some analogies that have been used in the past are based on technologies that now seem quaint, but at the time were perhaps the best examples of complex mechanisms, such as the ideas that neuron interactions are like telephone switchboards (e.g., Pribram, 1971, discussing his teachers), or mental forces are like hydraulic force mechanisms (e.g., Eysenck, 2004, discussing Freud's theories). Today, it is the computer and information theory that have given rise to the general framework that neurons are essentially information processing elements and the mind is a collection of computational functions that somehow results from the mass action of these neurons. Neuroscientists talk about such things as neural codes, neural circuits, neural functions, etc. And, in ordinary language, it is quite natural to talk about "programming the mind," or to say things like the "CPU is the brain of the computers." Other metaphors and analogies used by neuroscientists are related to the fact that electrical circuit theory is applied to understanding the mechanism of neuronal firing, or that neurons are laid out in a complex network of tree-like branching and connections. For experts, these metaphors are understood in the context of scientific practice of the field. But these metaphors also get disseminated through popular media, often in colorful language, as the following examples show:

> NEURAL CIRCUITS ARE ELECTRICAL CIRCUITS:
>
> Electrical impulses between brain hemispheres are "nonstop neural chit-chat" (*Newsweek*—Begley, 1995: 51).
>
> Neurotransmitters act ". . . like flipping on a light switch" and with too many neurotransmitters ". . . neurons burn out" (*Time*—Lemonick, 1997: 76).

These science-derived metaphors could be summarized under the general concepts that THE BRAIN IS A COMPUTER, BRAIN ACTIVITY IS ELECTRICAL, BRAIN WIRING IS FOR INFORMATION COMMUNICATION. However, in the ordinary language of non-experts, these only make up part of the way we conceive of the brain.

Definitions and common uses of "brain"

A useful starting point is to consider literal meanings and conventional metaphors of the word "brain" as found in the dictionary. In the *Oxford English Dictionary* (2nd edition, 1989) there are several variants that one can sort into physical and mental. In a physical sense "brain" refers to the biological organ; or "brain" can also refer to the substance of the organ. The meanings that are not physical are associated with mental activity or mental experiences and are often the source of metonymic links and metaphors. For example, because the biological organ of the brain is associated with thinking, it can serve as metonymic link for intelligence, as in the following examples:

> THE BRAIN STANDS FOR INTELLIGENCE:
>
> "if you had half a brain," "a hare-brained scheme," or in the sense of brain substance, "he's got brains." Two other conventional references to intelligence that do not use the word "brain" directly, are the following: "The books by that author are very cerebral" and "Use your gray matter."

In combination with the metonymic link that THE BODY PART STANDS FOR THE WHOLE PERSON, there is also the following:

THE BRAIN STANDS FOR AN INTELLIGENT PERSON:

"he is a brain," "braindrain," "braintrust," "the brains behind the organization." In "she is brainy" and "he is a scatter brain" there is a sense in which brain substance describes the make-up of a person.

If a mental task is easy, it requires no intelligence, and then it is called a "no brainer." However, if a mental task is demanding it requires some thinking effort. Conventional knowledge would state that physically demanding activities can be exhausting to the point where one's body is "worn out," or one is "beat," or one feels "out of shape." Thus, mapping mental tasks to physical tasks, there are some metaphors that reflect a change of shape of the brain while thinking:

THE BRAIN STANDS FOR THINKING EFFORT:

"braintwister," "rack my brains out." An early reference of mental effort is: "To beat his braines in the curious insearching of deep mysteries" (OED, 2nd edition, 1989, quoted dated as 1577).

There are also some entrenched metaphors of thought that do make reference to brain substance. For example, in the following metaphors a person's ideas are made of brain substance and that substance may come out of, or be put into, a person, or that substance can be detached, as in the following:

BRAIN SUBSTANCE STANDS FOR THE SUBSTANCE OF IDEAS:

"the idea is the brainchild of . . .," "brainstorm," "brainwash," "Let's pick her brain about the exam."

Mind versus brain metaphors

In addition to the common uses of the word "brain," which overlap with the meaning of mind, one can further analyze senses of "brain" by comparing the system of metaphors associated with both mind and brain. Lakoff and Johnson (1980, 1999) have identified everyday metaphors that conceptualize the mind, thinking, and other abstract mental entities. They list a large number of which here I give only a brief summary, chosen because they appear to be used for brain as well.

THE MIND IS A CONTAINER:

The mind is like a container or spatial region where thoughts are held as in: "in my mind," "clear your mind," "empty your mind," or "on my mind."

THE MIND IS A MACHINE:

The mind is like a machine in which thoughts are outputs, as in "crank out ideas."

THE MIND IS A RECORDING MEDIUM FOR MEMORY:

Related to THE MIND IS A COMPUTER metaphor, the mind is the location of the recording of memories: "my mind was a blank," "etched in my mind," "it made a vivid impression on me."

THE MIND IS A MUSCLE:

The mind is like a muscle in phrases such as: "mental leaps," "mental exercise."

IDEAS ARE FOOD:

Acquiring ideas is like eating, as when unbelievable ideas are considered "hard to swallow," and thinking is "chewing the fat."

UNDERSTANDING IS GRASPING:

Understanding is bodily grasping, as when we "grasp the concept" or "get a handle on the problem."

Because brain metaphors are not as entrenched as mind metaphors, the examples below have been collected from unsolicited expressions or retrieved from online corpora and transcripts. In the first set of phrases below, the brain is described metaphorically as a spatial container of thoughts and memory. The entailments are essentially the same as for the "mind," in that thoughts, ideas, or memories are construed as objects that can come into, out of, or be seen in a container. Note that the exact nature of the metaphor is under-determined; it's not clear if people are just substituting the word "brain" for "mind" in a container metaphor, or if the brain as an object in space is being construed as a container independently of the "mind as container" metaphor.

THE BRAIN IS A CONTAINER OF THOUGHTS:

Forgetting was described as ". . . it left his brain."[4]

The ideas of a thesis proposal existed ". . . in my brain but not yet on paper."[5]

Remembering is "stuff that sticks in our brain."[6]

Interviewing is to ". . . peek inside the brains of those at the top."[7]

Thinking about what to say is to ". . . reorganize my brain thoughts."[8]

An early use listed in the OED was "The Gazette seems to have the franking privilege on the brain" (1869).

The brain can also be talked about metaphorically as a kind of machine, where the mechanism has switches, gears, and operations.

THE BRAIN IS A MACHINE:

An act of thinking was described as ". . . her brain was churning."[9]

A person not thinking clearly said ". . . my brain wasn't switched on."[10]

Alternatively, a person not thinking well said "I'm feeling a bit sick and my brain is only running on half cylinders."[11]

The brain is also conceived as a recording or artistic medium, and learning is like creating a new recording. Notice that in the following metaphors the medium can vary in size from the "bumps" to "circuits" to "synapses." Like the corresponding metaphor for mind, these are related to THE BRAIN IS A COMPUTER metaphor.

THE BRAIN IS A RECORDING MEDIUM:

Rehabilitation after brain damage was described as: "the ultimate payoff of the discovery that the experiences of life are etched in the bumps and squiggles of the brain" (*Newsweek*—Begley, 1996: 59).

Drug addiction was described as: ". . . circuits that trigger thoughts and motivate actions are etched onto the brain [and] people, objects and places associated with drug-taking are also imprinted on the brain" (*Time*—Nash, 1997b: 69).

A rock band member stated that they were able to remember their songs after a long hiatus because ". . . we've played them so many times that they are etched in all the synapses of our brains" (*New York Times*—Strauss, 1999).

A comedian described the experience of a delayed reaction to her brother's death as if "the synapses in my brain didn't all get the message."[12]

Another metaphor is that the brain is like a muscle, implying that the brain exerts a force and sweats.

THE BRAIN IS A MUSCLE:

A memory contest was an ". . . Olympiad where you flex your brain instead of your muscles."[13]

A physics student referred to problem solving as applying "brain sweat."[14]

The metaphor that IDEAS ARE FOOD combines with metonymic links about the brain and intelligence or the brain and ideas, which implies that the brain needs nourishment.

THE BRAIN NEEDS IDEAS FOR NOURISHMENT:

Learning or reading was described as "feed your brain."[15]

Good day care was referred to as "essential brain food" (*Time*—Nash, 1997a: 50).

The metaphor that understanding concepts is like bodily grasping can also work with "brain" as the organ that does the physical holding.

THE BRAIN CAN UNDERSTAND CONCEPTS BY GRASPING:

A fast rising actor stated "I'm still trying to wrap my brain around what's been going on" (*New York Times*—Sterngold, 1999).

The fact that brain metaphors correspond well to mind metaphors would seem to suggest that the words "mind" and "brain" can substitute for each other. In fact, it is possible to add further examples of the above metaphors by merely substituting "brain" for "mind" in common phrases, such as the following:

"Hold this number in your brain"	versus "Hold this number in your mind,"
"His brain works in mysterious ways"	versus "His mind works in mysterious ways,"
"My brain can't handle calculus"	versus "My mind can't handle calculus."

In fact, in common everyday settings brain metaphors seamlessly coexist with mind metaphors. For example, in a children's educational store[16] there were several such confluences of mind and brain. One wall shelf was titled "brain aerobics" and it included products titled "Brain Shift: an electronic speed and reaction game," a puzzle book that contained "brain twisters," a Lego™ product called "Mindstorms," and a card game called "Visual brainstorms: a smart thinking game," which was described on the box as a "brain teaser."

Despite the possible overlap in meaning between mind and brain, they are not completely interchangeable. One trivial example is that "mind" can be a verb related to thinking, as in "never mind." More interestingly, there are common phrases about the mind as a noun that do not seem to apply so easily to the brain. Consider the following examples:

"I want to give you a piece of my brain"	versus "I want to give you a piece of my mind,"
"Will you change your brain?"	versus "Will you change your mind?"
"Open your brain"	versus "Open your mind."

Intuitively, the phrases with the word "brain" sound strange because the word "brain" is to some degree interpreted literally as physical object, although the meanings would certainly be intelligible in the proper discourse context. The reasons seem to be that the phrases are highly conventional for the word "mind" and that the physical dimension of the brain conflicts with the metaphorical sense of the verb (for a related psycholinguistics discussion, see e.g. Hare et al., 2004). It also suggests that in many, if not all, brain metaphors the physical feature of brain is accessible, though not necessarily prominent, in the act of comprehension. I will argue later (Section 5) that using the word "brain" to talk about mental phenomena is often reductionist, in metaphors or simple speech acts, in part because it can highlight the fact that the brain is not an abstract entity like the mind, but a physical thing in itself.

In summary, "brain" and "mind" have overlapping meanings and are used in similar metaphors. Table 2 lists a summary of mappings and relations. In this table, both "mind" and "brain" serve as metonymic links that can stand for the properties and items of mental experience and behavior. In this sense, "mind" and "brain" are mapped to each other at least for the purpose of comprehension. However, metaphors that make reference to the brain have physical features that are not part of metaphors that make reference to mind—namely the brain itself as a cerebral organ with circuits and synapses. Not all brain metaphors highlight this feature, but it is potentially part of a speaker's representation through semantic associations of "brain."

4. The causal role of brain states

The fact that mind and brain are mapped together does not fully determine the nature of this identification (for the speaker or the hearer). On the one hand, it may be that the brain organ is thought to merely enable or support the mind, and such language use merely implicates some vague association. On the other hand, it may be that the brain activity and brain states not only enable the mind, but they either cause, or are identical with, mental experience. In this section, I present examples of ordinary language that invoke the latter kind of reductionist perspective, thereby showing that folk neuropsychology does fill many of the same explanatory roles as folk psychology.

The explanatory roles of folk psychology can be understood by categorizing the verbs we use to talk about the mind, such as perceiving, believing, knowing, feeling, wanting, and intending. D'Andrade (1987) has sorted these verbs according to properties, such as location of cause (inside/outside mind), type of object (propositional/non-propositional), whether it is controllable, and whether the self is the agent or object. He also suggests that the main line of causation is the following:

$$\text{perception} \rightarrow \text{belief/knowledge} \rightarrow \text{feeling} \rightarrow \text{desire} \rightarrow \text{intention and action},$$

although potential feedback loops exist as well. Following a similar comparison as for metaphors, it is worth sorting out how people use "brain" as causal explanations. In many cases "brain" seems to serve as an alternative for mental terms, but often it adds a physical

dimension to the explanations of folk psychology, which may lead to additional perlocutionary effects for the speaker and/or hearer.

Table 2. "Brain" maps to "mind," so that "mind" and "brain" are used in similar metaphors

	Sources	**Folk psychology**	**Mapping**	**Folk neurology**
Input domains	containers, machines, muscles, mediums, handling, etc.	MIND	↔	BRAIN
Properties	space, parts, strength, surfaces, grasping, etc.	abstract entities		physical organ
Items	objects, products, motion, surface marks,	thoughts, feeling, memories, moods, etc.	↔	brain matter, synapses
Organizing relations	spatial relations, abilities, etc.	"in my mind," etc.	↔	"in my brain"

Brain states and feeling

The brain can be used when talking about feelings. In folk psychology, feelings are examples of mental phenomena in which the subject is the passive experiencer. It is especially so for sensations, as in "I feel tired." In such cases, the subject is often reporting their internal mental state of being. Given that these reports often refer to bodily or visceral feelings, it seems reasonable that people readily use "brain" to indicate the source. The following statements are all reports about the state of one's being that implicate the brain as mediating the mental state.

THE STATE OF THE BRAIN EQUALS THE STATE OF BEING:

". . . trying to compare feature pricing is enough to tire your brain. How is your brain this morning?"[17]

". . . tiredness blanketed her, blotting out cerebral activity" (*New York Times*—Kleinfield, 1999)

"now I'm brain dead"[18]

"I apologize for giving you another name a moment ago, that was a brain freeze on my part"[19]

"he got a brain lock and threw the ball away"[20]

"my brain is going to mush"[21]

"her brain exploded"[22]

"my brain was spaghetti . . ."[23]

Note that these phrases are generalizations of metaphors and metonymic links from the previous section. For example, the phrases "brain freeze" and "brain lock" are associated with the BRAIN IS A COMPUTER or MACHINE metaphors. The terms "mush" and "spaghetti" both refer to amorphous and weak material, which in combination with the metonymic link THE BRAIN STANDS FOR THINKING EFFORT leads to the inference that formless brain shapes are not capable of thinking.

There are two additional points that need to be made about these examples. First, these metaphors are related to the Subject–Self metaphor in which a person is divided between a

Subject and a Self (Lakoff and Johnson, 1999). The Subject is the experiencing, conscious agent, and the Self is the body or past states, which can be conceptualized as another person. For example, in the phrases, "I am beside myself" or "I am getting ahead of myself," the person is split into the experiencing subject and another person, and the physical separation indicates a non-normal state of being. The combination of the Subject–Self metaphor and the part–whole metonymic link THE BRAIN STANDS FOR A PERSON underlies THE STATE OF THE BRAIN EQUALS THE STATE OF BEING, except that instead of non-normal spatial relation there is a non-normal physical brain state.

A second important point about these examples is that the state of the brain is portrayed as the cause of the state of being, as experienced subjectively, and as the locus of the state of being. In other words, it is the brain that is in a poor state, which causes the mental experience of being tired, thinking poorly, or making mistakes. Using the terminology of conceptual blending, the brain and mental state are mapped to each other in the act of comprehension in such a way that cause and effect relationships are made to seem proximal and direct.

"Brain" and knowing

For the mental phenomena of "belief" and "knowing," the self is usually the agent and the location of the cause is inside the mind (D'Andrade, 1987). However, there are common phrases such as "the thought crossed my mind," "the idea came to me," in which a belief or knowledge is used as a grammatical subject, and the self is a non-causal passive experiencer. In other words, there is some conceptual elbowroom already in folk psychology for propositional knowledge that originates outside the consciousness of the subject. The following examples show that "brain" can be conceptualized as the causal agent that produces ideas, or as the source location of ideas.

THE BRAIN AS AGENT AND/OR LOCUS OF IDEAS:

A scientist discussing his fascination of rotating disks stated ". . . after about 40 to 45 seconds, the brain thinks, 'Wow, what's making that thing go for so long?'" (*New York Times*—Chang, 2000).

A corpus quoted someone as saying "when I showed it [the idea] was from my own brain . . ."[24]

A radio program described a songwriter whose songs ". . . sped from brain to paper without a hitch."[25]

The brain can also be the causal agent or locus of true self-knowledge, similar to the mind as the other of body.

THE BRAIN AS AGENT AND/OR LOCUS OF TRUE KNOWLEDGE:

A woman at the beach successfully swam out to a buoy and described her decision as a conflict in that ". . . my brain said you can do it, but my body said no you can't."[26]

A man who was trying to practice kick-boxing after a long hiatus said: "my brain knows what to do but my body won't do it [kick so high]."[27]

A wine grower described customers' preferences as ". . . they know in their brain but can't verbalize."[28]

At other times the brain is identified with the source of rational deliberation.

THE BRAIN AS AGENT AND/OR LOCUS OF DELIBERATION:

A movie review stated that "The movie *The Rock* forgoes plot detail and bypasses the brain on the way to the adrenal glands."[29]

A review of television programming stated that a program with famous actors shows ". . . how hard it is to ignore the famous even when your brain tells you to" (*New York Times*—James, 1999).

These metonymic links also follow from the combination of Subject–Self and BRAIN AS INTELLIGENT PERSON. But, in this case, the brain is contrasted to the physical body, as the controller or mediator of intentions, or the brain is contrasted to conscious mind, as the source of knowledge or ideas. Moreover, the brain has agentive properties of another person that can affect the subject, which is made possible by the Subject–Self split. This kind of division is also related to the next examples.

"Brain" and perceptual experience

For the mental phenomena of perception the self is usually the experiencing subject (i.e. the grammatical agent) and the location of the cause is outside the mind (D'Andrade, 1987). In other cases, the subject is sometimes located at the sensing organ. For example, one might say "my ears are tired of hearing this music." For misperceptions, both subject and cause can be co-located, as in "my eyes are seeing double." Although sensing organs are visible body parts, such perceptions could also be internalized into the non-visible brain, as in the following examples:

THE BRAIN AS EXPERIENCER OF PERCEPTIONS:

A woman was confused by the layout of a restaurant menu and stated "this menu is confusing my brain."[30]

A highway sign near Washington DC read: "Dumfries Manassas." A man misread the sign and reported that "for some reason my brain sees that as *dumb-ass-fries*."[31]

Note that this speaker did not locate the subject at the eyes because he was able to correctly read the sign. In fact, it would be logically strange if the speaker claimed to see both "Dumfries Manassas" and "dumb-ass-fries." However, one could say "For a second I saw the sign as *dumb-ass-fries*," in which case the speaker is the agent for both the correct and incorrect perception. But, in the above example, by making a reference to his brain, the speaker has separated his subjective self from such misperceptions, which is again a realization of the Subject–Self and BRAIN AS PERSON concepts. In this case, the "brain" is cast as the experiencer of the misperception, but not the experiencer of the correct perception. The speaker avoids the logical contradictory statement and does not directly claim to be the agent of the misperception.

This kind of refocusing of the experiencing agent to the brain is related to the social roles that can be expressed in the Subject–Self metaphor, in particular the relation of a person to standards of the self, as discussed by Lakoff and Johnson (1999). Consider these two phrases: 1) "I am disappointed in myself"; 2) "I disappoint myself." In the first phrase the experiencing self has the better standards of behavior and the other self (myself) is at fault. In the second phrase the social roles are switched, the experiencing self directly takes responsibility. In the case of the misperceptions, mental states, and motor-errors, the Self–Brain split is related to the standards of performance, knowledge, and self-control, and this metaphor underlies the possibility of blaming the brain for a variety of mental phenomena (as discussed in Section 7).

The latter examples also show that perceiving states that might be ascribed to the brain are not necessarily the moment to moment states of consciousness. This difference is realized when the referents for the grammatical agent and conscious speaker are split into the speaker's brain and the speaker himself. It is worth pointing out that one of the features of consciousness that is not easily explained by brain states or ascribed to a machine is the subjective nature of mental states—they are my states (Searle, 1984: 16; 1998: 56–7). The implications of this are that in the Subject–Self metaphor the brain does not fit easily into the role of experiencing subject. But we have also seen that the brain has some agentive and perceptual roles, and it is sometimes opposed to the body. Indeed, there are conventional phrases such as "mind over matter" and "brain over brawn" which together might situate the brain as both physical and non-physical.

Perhaps a better way to characterize these distinctions is under a more general conceptual schema of Subject–Brain–Body. In other words, the brain is not quite the same as a person or a body, but something in between that is also distinct from subjective conscious feeling. Depending on what is highlighted, for example, it is possible to talk about Subject–Brain and the relation of brain states to mental states or brain knowledge to conscious knowledge, or it is possible to talk about Brain–Body and the mediation or control of body movement through the brain.

Summary

Currently, I have no examples of unsolicited speech acts that use "brain" as an agent for either desires or intentions. However, given the above set of examples, it is easy to imagine that in the right context one could comfortably use "brain" as the agent for wanting or intending. If people, for example, hear or read about how the dopaminergic system is involved in chocolate cravings (e.g. *Time*—Nash, 1997b) then one might say "my brain wants chocolate," or perhaps even "my dopamine neurons want chocolate," without breaking Gricean maxims of discourse. Speculatively, given the metaphors that already structure our concepts about the brain and mind, it is just a matter of time until the diffusion of terms and ideas from neuroscience makes it easy to use the brain for all the causal roles of folk psychology in ordinary language and in casual settings.

In summary, we can say more about the mapping of brain to mind in metaphor comprehension beyond the fact that both can refer to similar items in Table 2. The brain can have a causal role in the presence and experience of mental states (i.e. being tired, thinking poorly, making mistakes), the brain can have an agentive role in the process of thinking (i.e. the locus of knowledge, being rational, deliberating), and the brain can have an ownership role in some perceptual experiences (see Table 3). All together, it suggests that the brain stands in a relationship to mind that is not just enabling, but somehow directly responsible for mind states and activity. This is essentially a reduction of mind to brain reflected in an ordinary language that is folk neuropsychology. Conversely, the subjective quality of mental states cannot easily be reduced to brain states, so that even if brain states are believed to cause subjectivity, that kind of language is more obscure and harder to depict (see Rorty, 1980: ch. 2, for a possible means to discuss subjectivity as neural patterns).

5. Brain images in culture

So far, I have been showing the nature of folk neuropsychology in which explanations for behavior or mental phenomena reference the brain, and this referencing includes a physical

Table 3. The concept of "brain" not only maps to "mind," but also causal, reductive, agentive, and/or experiencing roles

	Folk psychology	**Mapping**	**Folk nueropsychology**
Input domains	MIND	←	BRAIN
Properties	abstract entities, agent, subjectivity		physical organ with a solid form, agentive
Items	mental states, feelings knowledge, experiences, memories, thoughts	*caused by, identical with produced by, located within*	brain states, brain activity the brain, brain activity
	motor, sensory, perceptions	*mediated, or controlled by, experienced by*	the brain, brain processes

and/or causal feature. In this section, I will present several cultural symbols of the brain and situate their meanings with respect to metaphor comprehension. Cultural symbols are representations, icons, or imagery, that have one or more shared meanings among members of a society, which are easily recognized, can be used with little context, and are understood without reference to the original site or history of its production. The meanings in cultural brain symbols can be understood as another set of metonymies and concepts that are used in metaphors about the mind/brain. But, in some cases they are used to generate inferences that go beyond the initial brain-to-mind metaphor mappings, and they may have distinct social effects due to their imagery or concreteness.

How do brain symbols come about? Star (1992: 207) suggests, that from a sociology of science point of view, the mind and brain stand in relation to each other as abstract and concrete. The mind is an abstract entity that people know by subjective experience. But the brain is a hard thing to experience directly, unless you take a neuroanatomy class. Scientists try to join the abstract and concrete in part by developing techniques, practices, and models that create tangible objects that mediate scientific knowledge (Star, 1992). In neuroscience and cognitive science, some of the possible imagery of the brain includes pictures of actual brains, brain scan images, graphs of brain waves imposed on an outline of a head, or perhaps even a raster graph of neuronal firing. A few of these objects have become icons in our society and part of our shared knowledge. In that sense, a brain icon is a concrete symbol that is accessible or usable in metaphors, jokes, and advertisements. Brain scanning images in particular have become a very compelling form of science narrative, or what Dumit (2004) calls "visual facts." They have a potential for societal impact that can capture reductionist explanations which seems to have nothing comparable in folk psychology. Moreover, the concrete nature of brain symbols in combination with the conceptual mappings of brain to mind enables inferences about the mind that extend some of the metaphors presented previously.

Localist mapping of brain to mind

Perhaps the most straightforward icon of the brain is a picture of the folds and convolution of the brain itself. Such a picture is sometimes used as a metaphor of intelligence. In the following example, there is a visual blend of the physical brain and conventional metaphors about thought, which suggests the following metonymy.

THE BRAIN ORGAN STANDS FOR INTELLIGENCE:

A recent advertisement for a newspaper combined visual and conceptual domains (*New York Times*, 18 January 1999). Visually, there is a light bulb joined to a brain that is

depicted as folds and convolutions (not anatomically correct) on top of the bulb. Conceptually, the image consists of the metonymic link THE BRAIN STANDS FOR INTELLIGENCE, the metaphor that UNDERSTANDING IS SEEING (i.e. "I see what you mean"), and the entailment that GOOD IDEAS ARE LIKE LIGHTBULBS TURNING ON. The mapping of light bulb to brain in the visual blend sets up the punch line of the advert: "light up your brain."

A popular expression of humor involving the brain is a "joke phrenology" in which pictures or drawings of a brain include regions that are labeled for some obviously inappropriate function. For example, in a valentine card I once received the left and right halves of the brain were depicted and labeled according to some high level opposing functions, in this case logic and emotion; and the intent of the card was coded with those regions. The card is a joke of course and is not intended to support phrenology or be anatomically correct, but it represents the fact that there exists a common sense understanding about what brain regions do. In other words, the card invokes the cultural schema of common sense localization, in which regions of the brain are conceived as serving special mental functions or personality functions.

BRAIN REGIONS = MENTAL FUNCTIONS:

Some examples of common sense localization are clearly not intended as a joke, but more of an application of neuroscience. There is a recently developed board game, called "Cranium," that is described on the box as a "game for the whole brain."[32] The game consists of different challenges, such as drawing or event recall, which supposedly tap into different brain regions. Whether or not the game is up to date on the latest segregation of cognitive function in neuroscience is secondary to the fact that the designers sell their product as a scientifically valid localization of mind functions into brain regions.

Brain scanning technology, such as magnetic resonance imaging (MRI) and positron-emission tomography (PET) are producing the newest and perhaps the most provocative kind of imagery in the emerging folk neuropsychology. The images typically depict the brain, either as an X-ray-like image in MRI or as a brain organ outline in PET. Such images have quickly achieved the status of common knowledge, often through the expression of brain metaphors and metonymic links. For example, a billboard advertisement for a local community college displayed MRI of a brain with a caption that says "exercise your brain" (i.e. THE BRAIN IS A MUSCLE).[33] A sportscaster, discussing the stupidity of fans who try to sneak in beer through the very high security at the Super Bowl, joked that "they need to do brain scans" to see which fans are dumb (i.e. THE BRAIN STANDS FOR INTELLIGENCE).[34]

As brain images become more commonplace, it is worth examining what they may symbolize. In both functional MRI and PET research regions of the brain that are shown in brighter/darker colors typically indicate more/less activity, in one experimental condition relative to another, as measured by that device. For an expert, these images are understood against the background of the experimental, mechanical, statistical, and image processing procedures that go into measuring, analyzing, interpreting, and assembling all the data. In principle, the scientific data could exist without images at all, but only in tables, and in fact some experts find it critical to look at the data that way (Dumit, 2004). For non-experts, such images have come to represent a new concept about the brain in which colored regions refer to mental activity. More subtly, and perhaps more importantly, it promotes the general notion that colored regions represent an event of the brain that underlies some mental state or mental experience.

COLORED REGIONS IN BRAIN IMAGES EQUAL MENTAL STATES:

> A cover article in popular media entitled "Glimpses of the Mind" started off by asking: "What is consciousness? Memory? Emotion? Science unravels the best kept secrets of the human brain." A small picture within the first paragraph shows a PET image with the caption "mental snapshot: computer image of a sad thought" (*Time*—Lemonick, 1995). The picture together with the caption superficially suggests that scientists have reduced "a sad thought" to an image of some brain part.
>
> In a television commercial for Hammerhill™ paper, an MRI image of a brain was displayed, then a man was shown viewing a piece of paper with two men in white laboratory coats taking notes behind him, and a narrator's voice said "Here is the brain of a person viewing a pie chart." Then the advert showed a second MRI image with lots of red spots and the narrator said "Here is the brain of a person viewing a pie chart on Hammerhill™ paper." And the man was shown reading the report with a big smile on his face.[35]

The television commercial is a visual blending of two input domains in the act of comprehension and inference. There is the domain of scientific experiments, complete with scientists in laboratory coats taking notes, laboratory equipment, and a screen with a brain image; and there is the domain of viewing business reports, which are typically boring. Comprehending the commercial entails the construction of a blended space that combines the visual display, the narrator's words, and common knowledge about the authority of science and dullness of business reports. In the blended space, the colored brain and smiling face are brought together and directly linked as cotemporaneous. Thus, despite the fact that the scene is somewhat humorous and no pretense is made of a serious or real experiment, the invited inference is easily reached. Notice that even though the popular media story about "sad thoughts" is presented in seriousness, it also taps into the same capacity for conceptual integration. The reader automatically combines the caption with the image and infers a direct connection between the brain and the mental state.

An ironic side point in the commercial is that the man is not lying inside an MRI machine but just wearing a cap on his head for recording brain waves. That mistake is not important for understanding the commercial, but it indicates that any technical-looking device can often generically represent measurements of brain activity. Indeed, as I will show in the next subsection, high-tech measurements of brain activity are also examples of concrete references to brain that can come to stand for mental phenomena.

It is noteworthy that many of the examples of brain symbols above are involved in identifying brain states to mental states or functions, and are thus related to the larger conceptual schema about common sense localism. In other words, not only are brain scans provocative, but they fit into the conventional notion that mental states or functions equate to brain regions. Consequently, brain scans are now easily recognized as a picture of a living, thinking, working brain, and the connection between colored regions and mental states or functions is common knowledge. Thus, brain symbols are also part of the conceptual schemas that make up folk neuropsychology. Moreover, because the physical brain itself is so prominent, it further supports the idea that the brain-to-mind mapping in folk neuropsychology is reductionist.

Inferences and metaphor extensions

Dumit (2004) has pointed out that brain scan images themselves not only have become cultural artifacts but they also carry the weight of scientific knowledge, even though

scientists themselves are wary and critical of such simplifications (see also Nelkin and Lindee, 1995, regarding genetics). In this sense, brain symbols that are used in metaphors provide a domain of knowledge that not only includes the meaning attached to those symbols, but also adds a sense of authority or technical correctness. Such symbols can be taken up by other communities with vested interests, such as patient groups, policymakers, lawyers, or insurers, and used out of context for advancing certain arguments (Dumit, 2004; Nelkin and Lindee, 1995).

Consider the following examples of the power of brain images regarding child development. The executive director of a non-profit organization promoting the need for early education stated that: ". . . because you can see the results [of brain development] under a microscope or in a PET scan, it's become that much more convincing" (*Time*—Nash, 1997a). Similarly, at a business lunch meeting in San Diego the film director/activist Rob Reiner described an MRI image of an abused child that was less well-formed than that of a normal child, and stated: ". . . now with a picture we really have proof."[36] Out of that kind of publicity new calls were made for early intervention and more money for social programs such as Head Start, and two state governors put forth legislation to distribute Mozart CDs (*New York Times*—Goode, 1999). In the past, developmental psychologists had made the same arguments, but as a neuropsychologist pointed out "the brain was the hook."[37]

In addition to matters of policy, the influence of brain symbols makes it easy to generate inferences in a broad range of situations. From a cognitive semantics perspective, this is a natural evolution of metaphor comprehension and production. The examples below use an iconic or symbolic reference of the physical brain, in combination with the convention that "more is better," to produce inferences that more or less physical activity of the brain is better or worse, respectively.

On the margins of science there is a non-academic, non-Ph.D., sports psychologist who uses the Meyer-Briggs personality test to pick out more competitive athletes. He refers to his analysis as "brain typing," and even though he does not use brain scans, he states that:

> "ISTPs are the fiercest competitors in sports . . . [if] I could show you a picture of Michael Jordan's brain, he's strongest in the right posterior part, his No. 1 gift is spatial thinking. [regarding Karl Malone, another player] . . . until he learns how he's wired, he's going to continue to fail." (*Los Angeles Times*—Dufresne, 1998)

By identifying a particular brain region and the possibility of using MRI or PET pictures the psychologist is using the modern symbols of neuroscience to sell his idea. Notice that it is not clear what he means by "strongest in the right posterior," but there seems to be an assumption that more activity is better, even though for well learned skills it may be the opposite (not to mention the fact that leaping ability may have had something to do with Jordan's success).

There are other symbols of brain science that are not necessarily easily pictured but can easily invoke some imagery. This next example demonstrates the possible diffusion of scientific metaphors through popular media.

> NEURAL CIRCUITS ARE ELECTRICAL CIRCUITS:
>
> With positron-emission tomography (PET), a pediatric neurobiologist watched the regions of a baby's brain turn on, one after another, "like city neighborhoods having their electricity restored after a blackout" (*Newsweek*—Begley, 1997).

This metaphor was repeated, almost verbatim, in a story about a daughter caring for her parent who had a bad stroke. The woman is quoted:

> "I find picture albums that I take to the hospital trying to jump start my mother's brain . . . as more words emerge whole sections of her brain are coming back online like neighborhoods lighting up after a blackout." (*Washington Post Magazine*—Thompson, 1999)

The context of a stroke is different than the context of infant development but the metaphor and imagery are easily reapplied.

The following two statements also reference a symbol of brain activity which is often presented graphically in scientific journals, but for the non-expert it does not necessarily invoke an image.

> BRAIN WAVES STAND FOR MENTAL ACTIVITY:
>
> One woman joked about a pregnant woman's forgetting as ". . . that baby is taking away some of your brain waves."[38]
>
> NEURONAL FIRING STANDS FOR MENTAL ACTIVITY:
>
> A math professor recently said in class, ". . . keep your neurons firing to notice this form of the equation."[39]

Again, in both of these examples something physical is equated with mental functions or capacities. Although waves and neurons may not be something easily imagined, they are something very concrete and tangible, which can be physically measured. The implicit inference is that more/less physical brain action is associated with better/worse performance, memory, or attention. To be sure, such inferences are also simplifications of the kind of statistical summaries used to interpret brain activity, but those details and subtleties only complicate the conventional notion that more is better.

Note that for metaphors of the mind, we can talk about "paying more attention," "chewing on this idea more," or "mental energy," in which a physical domain structures our conceptualization of mental functions so that more of it (i.e. more pay amount, more chewing or more energy) implies more mental function. The important difference of course is that some measurement of the physical brain itself is what gets increased/decreased to conceptually produce more/less mental function. Also, the object that stands in for brain activity could seemingly be anything scientists measure from the brain, so long as that object becomes commonly recognized. Thus, the metaphors and mappings about the physical brain, with or without brain scan imagery, and the inferential extensions regarding the amount of brain activity, are also part of folk neuropsychology.

In summary, there is a general conceptual schema that MORE BRAIN "ACTIVITY" IS MORE/BETTER MENTAL "FUNCTION," where "activity" is any brain measurement that is commonly understood. This schema is an extension of metaphor comprehension and the processes involved in resolving references, identifying mappings, and organizing relations.

6. The commitment and application of folk neuropsychology

What are people doing when they invoke conceptual schemas of a folk neuropsychology? On the one hand, it is possible that speakers who use neuroscience terms are just repeating idioms or phrases they heard somewhere, without much commitment to, or processing of, the internal semantics. On the other hand, many examples I have shown are not conventional phrases, but productive statements that reflect an active and shared network of concepts regarding the relationship of brain to mind. This section will expand on the productivity of

folk neuropsychology by showing how people who use it might be committed to its underlying schemas, and by showing the varied reasons that people might use it instead of folk psychology.

Consider the evidence for reductionist conceptual schemas from a single individual, a radio show host (Liane Hansen, National Public Radio) who moderates a weekly word puzzle game. At various times she has directly made references to brain as a mechanistic source of her mental states. Her statements include THE BRAIN IS A MACHINE metaphor:

> "after last week's puzzle . . . it did get my brain going"[40]
>
> "my brain was steaming from last week's challenge"[41]
>
> "my brain is a little bit smoky from the past week's challenge . . ."[42]

She also uses the Subject–Brain conceptual split in which the brain is juxtaposed to the subjective self:

> "well my brain was really on vacation. I figured I'd wait till I got back to work . . ." (but she was not physically on vacation that time);[43]
>
> "I'm about to go on vacation for three weeks and I'm afraid my brain is already at the beach";[44]
>
> ". . . are you ready to put your brain to work today."[45]

Again, these metaphors reflect the conceptual schemas that the brain is a machine-like entity that causes mental states, as well as the schema that non-normal brain locations correspond to non-normal mental states.

More generally, for some people, folk neuropsychology is consistent with their reported beliefs. Fahrenberg and Cheetham (2000) performed a survey of beginning university students on their preferred explanations of mind and body. They found that over half (113/209) preferred a neutral viewpoint that made no commitment to materialism or idealism, many preferred a dualism (62/209), and fewer (23/209) preferred a materialism (Fahrenberg and Cheetham, 2000: Table 1, p. 51). It suggests that at least the students who prefer materialistic explanations might use the language of folk neuropsychology and intend it as such, and the neutral students would at least find it plausible as the correct way to speak about mental experience and behavior.

It is obvious by now that most, if not all, of the examples presented here that used neuroscience terms were not accurate applications of neuroscience theories. Attention does not equate with keeping neurons firing, nor does memory equate with etching in synapses. At best, such statements are loose interpretations of attention as facilitation and memory as strengthening of synaptic efficacies. One might claim, therefore, that because folk psychology is primarily pragmatic, it has no use for neuroscience, at least not in any technical sense (Wilkes, 1993). Contrary to that opinion, it seems that the technical or "scientific" sense of folk neuropsychology often motivates its use, although strict accuracy is irrelevant. For example, as stated previously, brain images carry an authoritative force that is often used to promote certain policy positions (Dumit, 2004), or just to be used jokingly, as in the television commercial for business paper. Also, stories about neuroscience research in the media are intended to be provocative or reflect the latest discovery about the brain, which in turn can make those ideas simply an entertaining and fashionable topic for conversation.[46] Another benefit to adopting technical terms is that some people might just prefer to talk about behavior in reductionist terms. One reason could be that it reflects their beliefs, or

perhaps as a matter of convenience, as when splitting the subjective self to talk about non-normal mental states or experiences. There is also the perlocutionary effect of using folk neuropsychology to impress the hearer with novel phrases, such as "keep your neurons firing." Consider the following: a recent article about the Internet stated that

> "Just as the number of neurons and neurotransmitters determines cognitive ability, the number of individuals and interconnections between them drives the pace of innovation." (Hamel, 2001: 170)

This statement is an application of folk neuropsychology which not only is intended to explain Internet innovation, and perhaps make a general point about networks, but also is intended to sound somewhat scientific (even though a better analogy would have been to use "synapses" instead of "neurotransmitters"). In either case, it would be a loose interpretation of theories of brain function, with terms from neuroscience that are now becoming more common, for the purpose of explanation. The important point is that such technical vernacular in the use of folk neuropsychology is interpretable, it carries meaning, and it can perform real explanatory and/or pragmatic work even if it is not scientifically accurate.

7. Brain augmentations to folk psychology

The emergence of a new folk neuropsychology leads to a question regarding the coexistence and assimilation with folk psychology. Clark (1996) has suggested that modern neuroscience will mainly serve to enrich the existing folk psychology. In contrast, the examples in this article suggest that modern folk neuropsychology will augment folk psychology with new conceptual schemas that are distinctly related to the physical and concrete features of the brain, as represented in symbols and icons, and the brain's causal role with respect to mind. The new conceptual schemas will expand or change common sense understandings in two ways: 1) by filling in the gaps in folk psychology, as also considered by others who look at public understanding of genetic science or biotechnology (i.e. Ten Eyck, 2005), and 2) by placing blame on the brain, as also suggested by others who look at neuroscience and culture (Valenstein, 1998; Dumit, 2004), but in this article it appears to occur for broader and more ordinary settings.

The first kind of expansion offered by folk neuropsychology is that new brain symbols and concepts may fill in the gaps of folk psychology. One kind of gap likely to be filled from neuropsychology is the understanding of abnormal conditions such as schizophrenia, drug addiction, depression, and memory loss. In addition, the science that surrounds these conditions creates new schemas for explanations of behavior and mental experiences. For example, Valenstein points out that the concept that chemical imbalances are responsible for many psychiatric conditions has been promoted aggressively by the drug industry since the 1950s, despite the fact that such theories are still, to this day, immature (Valenstein, 1998: 236). Some drugs, such as Prozac, have readily become part of our vernacular because of advertisements, campaigns, and books for popular consumption, even though many fundamental questions about its effect are unanswered. From a cognitive semantics perspective, it seems that Prozac™, or whatever drug is promoted as such, is easily accepted because there is a conventional schema already in place regarding the need to keep chemicals in balance.

Interestingly, the neuroscience fact that drugs act through receptors on synapses, is also becoming common knowledge and more concrete. A television advertisement for the antacid drug Zantac™; showed a line drawing image of dots passing back and forth between

two bulb outlines, presumably indicating neurotransmitter action at a synapse, while a narrator described the drug's function and benefits.[47] The graphics provide a brief and schematic visual story that chemicals moving between cells are a good thing. In a comical twist, a recent television advertisement for a clothing store proclaimed their colorful clothes and comfortable jeans ". . . activate feel good receptors," and for a brief moment the advertisement showed a line drawing of a human figure with small circles flowing from the brain to the body.[48] The narrative and accompanying drawing reflect a conceptual schema, in this case derived from neuroscience and the drug industry, that chemical actions and their receptors cause emotions or moods.

Another example where folk neuropsychology is already filling in gaps is in understanding child development. Consider the following examples. A mother recently said that she was worried that her two year old child was not getting "enough connections" owing to the lack of stimulation.[49] An employee at a day care center (in a different city) recently recommended teaching Spanish to a 19 month old "to help connections grow, or at least that's what I read."[50] Both speakers, neither of whom are professional scientists, are using ideas disseminated from neuroscience to help form a folk theory that explains how a child acquires knowledge. It is a more specific and reductionist characterization of development than saying something more abstract, such as "a child needs stimulation." In this sense, the reference to the tangible concept of growing neural connections helps fill in the gap of how a child learns and what the parent should be doing to help that. And even though connections may or may not invoke imagery, the brain can still be a compelling symbol.

The second kind of expansion of folk psychology seemingly taking place is that modern brain symbols provide tangible representations for the target of blame assignment. One arena where this becomes important is mental illness, where it has been pointed out that a reductionist perspective of mind-to-brain influences the acceptance of biological causes of mental illness (Valenstein, 1998; Dumit, 2004). In fact, just labeling these things "diseases" marks a reduction to brain and has broad implications, as evidenced by the contentious debates that have taken place on the pages of Op-Ed pieces (e.g. Sontag, 1998). The debates often revolve around responsibility for behavior and their social implications. In this regard, Dumit (2004) also points out that interested communities are keenly aware of the visual effects that brain scanning images can have, and they often use such images for negotiating, promoting, or defining categories of abnormal or normal brains. The abnormal/normal distinction, as portrayed with brain images, is part of the construction of the objective self.

However, in some of the examples I have presented here, the brain can take on the locus of blame for more mundane stuff. This follows from a combination of THE BRAIN AS AGENT AND/OR LOCUS OF KNOWLEDGE and THE STATE OF THE BRAIN EQUALS THE STATE OF BEING, which together produce an inference that might be conceived as "THE BRAIN IS RESPONSIBLE FOR MENTAL LIMITATIONS." For example, a phrase such as "my brain knows but I can't verbalize" makes a distinction between the immediate feeling of knowing something and the ability to act on that knowledge. It reflects the fact that there are physical processes in the brain, which are coordinated with consciousness, which are necessary for an agent's ability to execute some intended response, whether that response be simply motor output or something more subjective, like memory recall (as in the phrase "it's on the tip-of-the-tongue"). Several of these cases occur at those times when our expectations are disrupted, because one can't verbalize, can't control or coordinate one's body as intended, in which case the mediating/causal role of the brain reveals itself to the foreground. In fact, it is because these events occur during errors that the brain is not just a cause but also relieves the speaker of

responsibility for the mistake. In essence, the brain is getting cast as the objective self and takes on (or relieves) some blame as part of its agentive role. More generally, brain scans, or related imagery, objectify all sorts of mental states or entities (i.e. alertness, knowledge, memory, attention, etc.) which help make the role of the brain as a causal agent concrete and tangible. Thus, even in these ordinary and common situations, the objective self may be updated, modified, and/or constructed. Although less is at stake than illness/disease or abnormal/normal definitions, it could be a microcosm of drawing boundaries between the subjective and objective self. Over the long term, such small instances of folk neuropsychology could construct and reinforce reductionist perspectives on brain and mind.

In summary, we can extend the description of inferences to include the fact that this occurs in social contexts. As such, the role of inferences in folk neuropsychology is not just extending metaphors, but applying them for perlocutionary effects of invoking emotions or sounding authoritative (as discussed in Section 5), and for filling in gaps in folk psychology and assigning blame.

8. The assimilation of folk neuropsychology

In addition to the coexistence of folk neuropsychology with folk psychology, there is also a question regarding the relationship to other folk theories of behavior. In this section I will briefly point out some of these and suggest that neuroscience can be easily assimilated with these because they ultimately depend on the brain. Common sense dualism, however, could be an exception, especially because of the qualitative nature of the subjective self. And finally, I will also suggest that folk neuropsychology has some relevance to philosophical discussions of folk psychology, mostly with respect to the practical side of how people talk about the mind.

Theories of the mind and folk neuropsychology

Since the beginning of modern neuroscience in the late seventeenth century (e.g. Zimmer, 2004), there have been several attempts to construct reductive theories of behavior. Phrenology was an early attempt at reducing mind to brain, but it did not seem to try to explain the mind so much as reify a particular version of folk psychology (Shapin, 1979). However, as discussed previously, there is a common sense understanding about the localist notion that brain regions correspond to mental functions, which is more general than phrenology, and perhaps an outgrowth of it. A contrast to localism is sometimes called "connectionism" or "parallel distributed processing," in which mental functions arise from the cooperative neural processes distributed throughout regions of the brain. Some ordinary language samples that resonate with connectionism include comments about "connections" in the context of child development, "synapses" in the context of memory, and "interconnections" for cognitive ability. Although other non-localist ideas, such as "holism," have also been around since the nineteenth century (e.g. P.S. Churchland, 1986), there does not seem to be a prominent brain image related to distributed processing. It remains to be seen if some imagery or symbol about distributed circuits, converging connections, or distributed patterns of activity will become more recognizable, in the way that colored regions in a brain scan have emerged as a cultural symbol.

There are several other twentieth century theories that have had an impact on common sense understanding. For example, many terms from Freudian psychology, such as "ego" or

"libido," have become part of our contemporary vernacular. Irrespective of the status of Freud's theoretical framework, the fact remains that Freud had a big impact on science and society, and today people use derivations of these concepts for a variety of explanations and social functions (Churchland, 1995). For example, people sometimes make references to unconsciousness as causes of mental states, such as unconscious desires or needs (D'Andrade, 1987: 115). It is interesting that some neuroscientists are rekindling interest in some Freudian concepts, but their intent is not to support Freud's theory of psychic energies or his psychoanalytic remedies. They are more interested in giving a neural basis to modern notions of unconsciousness, drives, or reactivation of memories during sleep (*Newsweek*—Guterl, 2002). To some extent, it may be an example of the backward influence of the folk theories, or at least some of those suggestive Freudian terms that have diffused into Western culture, back to scientists.

Theories of classical conditioning and genetics are two other systems of thought that have some influence on how people explain behavior. Linde (1987), for example, demonstrated that people sometimes use the notion of conditioned behavior to explain important decisions or acts in one's life. Nelkin and Lindee (1995) have also written extensively on how genes have become widespread cultural symbols that can explain behavior, motivate policy, reinforce stereotypes, and stir up controversies. However, both of these fields are also directly linked to active research in neuroscience. Thus, neuroscience will incorporate, interact, and evolve with these other scientific theories about behavior. And because these other theories will have to include the brain in some way as a link to behavior, it seems that folk neuropsychology should easily grow and diffuse along with these other systems of thought. For example, we can talk about the brain being hard-wired to mean that there is a genetic determination of brain function or processes, or we can talk about the brain getting rewired to mean that conditioning has permanently changed brain function. These metaphors are associated with the computer-related metaphorical schema that BRAIN WIRING IS FOR INFORMATION COMMUNICATION. This combination of concepts suggests that there is a more general common sense understanding of mind and behavior based on a wide range of interacting scientific narratives that include genes, conditioning environments, social-economic pressures, cultural practices, and of course brains.

Dualism and folk neuropsychology

In contrast to reductionist theories of behavior, dualism creates some conflicts with folk neuropsychology. Namely, common sense (Cartesian) dualism is the conceptual schema that mind and consciousness are not a physical thing like the brain, and therefore can't be reduced to it.

In the study by Fahrenberg and Cheetham (2000) discussed above (Section 6), materialism was most often (124/199) chosen as the least preferred belief. It suggests that some students harbor apprehension about reductionism. More negatively, it suggests that entrenchment of Cartesian dualism will somehow prohibit a complete uptake of neuroscience into everyday language. This possibility cannot be completely ruled out because the popular concept of "soul" or "spirit" is promoted by conservatives as an anti-reductionist reaction against materialism.[51] More likely, to the extent that "soul" or "spirit" is bound up with subjective feelings, then, as we have seen, it may be difficult to ascribe a causal role to the brain. However, to the extent that "soul" or "spirit" is related to properties of essential or objective selves, then, as we have also seen, the brain can be the locus of such properties (cf. Nelkin and Lindee, 1995, on "genetic essentialism").

The future of folk psychology and folk neuropsychology

Finally, it is worth reviewing the relevance of folk neuropsychology to philosophical discussions about the future of folk psychology. Some philosophers, most notably P.M. Churchland (1981, 1998) and P.S. Churchland (1986; Churchland and Churchland, 1996), propose that eventually theories of the brain will be mature enough to demand discarding or revising folk psychology and replacing it with a more correct set of terms and concepts prescribed by neuroscience, hence their position is called "eliminative materialism." In contrast, other philosophers are more optimistic about the fate of folk psychology, even though they agree that it will one day be reduced to theories of the brain. The main reasons are that folk psychology is actually a very successful theory (Fodor, 1987; Horgan and Woodward, 1985), or that mental phenomena still have causal efficacy, and a causal role in our explanatory theories (Dennett, 1981). Still, others take the position that folk psychology will not really reduce to theories of the brain because they are more like two parallel languages that properly operate on two different things, mental or neural, not two different levels of the same thing (Bennett and Hacker, 2003).

An issue in the philosophical literature that has received little attention is the ordinary language of brain and mind. It has been noted that the vernacular of neuroscience will likely grow (Churchland, 1998; Wilkes, 1993), but that is seen to be distinct from the premise of eliminative materialism. An analogy is the following: heat is scientifically reduced to molecular structure and movement, and even though folk theories that appealed to little hot things are discarded, we can still talk about heat in a useful way. In other words, the folk theory of heat has been eliminated, independent of the vernacular. Indeed, the examples presented in this article are only indicative of the materialist and reductionist part of relating brain to mind, and not a broad revision of folk psychology. However, looking closely at the vernacular it seems that folk neuropsychology has connotations and pragmatic roles of its own. Namely, folk neuropsychology incorporates compelling imagery, jokes or facts that can entertain, amaze, and/or sound technical, novel terms or imagery that help articulate the common sense notion that the brain causes mind, tangible symbols that become an object of blame, or simply the convenience in using brain to stand in for the objective self. These pragmatic roles of folk neuropsychology are either absent in folk psychology, or in folk psychology they lack a physical referent that can make it concrete. In this manner, folk neuropsychology comprises enhanced, augmented, and alternative conceptual schemas for talking about mental phenomena. These schemas may not be as radical a shift in explaining behavior as saying that heat is not made of hot things, but, instead of just a side issue, it could be that diffusion of neuroscience and widespread use of folk neuropsychology will bring about transformations in the existing folk psychology (Churchland, 1995), such as how mental phenomena are conceptualized, the connotations of agency associated with behavior, and the symbols that represent persons and their states. Speculatively, the proposed co-evolution between theories of brain science and folk psychology (McCauley, 1993) will be mediated by a third, intermediate-level, network of concepts that is folk neuropsychology.

9. Conclusion

In summary, I have shown that brain and mind have overlapping referents, brain and mind are conceptualized similarly, reporting brain states can be substituted for reporting mental states, and brain images engender new shared cultural symbols that characterize mental phenomena. The use of these brain references to talk about mental states and mental experiences

is a reductionist mode of explaining behavior. In that sense, it is a rudimentary folk neuropsychology.

I have also applied a cognitive semantic analysis to the use of metaphors, speech acts, jokes, advertisements, and other images to the ordinary language of "brain." Other work in the public understanding of genetics, or science and technology more generally, has also examined metaphors, such as frequency and types in popular media (Liakopoulos, 2002; Christidou et al., 2004) or development and change of analogies over time in popular science (Knudsen, 2005). For an analysis of lay understandings, some work has used interview techniques to evaluate how science is assimilated (Richards, 1996; Shaw, 2002; Emslie et al., 2003). Some analyses of culture and science have also focused on the nature of science narratives and their impact on policy discussions, legal decisions, and personal attitudes (e.g. Nelkin and Lindee, 1995; Valenstein, 1998; Dumit, 2004; Ten Eyck, 2005).

The cognitive semantic analysis of metaphor, speech acts, and imagery in ordinary language is complementary to all these approaches because it focuses on the network of conceptual schemas underlying common sense understanding. As well as identifying and categorizing metaphors as a whole unit, deconstructing the meanings of cultural symbols, or situating social perspectives, a cognitive semantic analysis decomposes the underlying concepts that organize and structure the way we conceive and talk about things. The cognitive semantic analysis helps reveal the source of entailments, generalizations, inferences, discourse effects and social meanings involved in everyday language. This kind of analysis seems especially crucial for the public understanding of neuroscience because the mind is something abstract that we know subjectively, theories of brain function are still immature, and the dualist sense that the mind is not physical makes this a difficult matter to talk about in purely objective terms.

Acknowledgement

I would like to thank the anonymous reviewers for their especially insightful and detailed comments.

Notes

1 http://www.loc.gov/loc/brain
2 http://www.sfn.org
3 The phrase "fry your brains" has earlier uses in time, but certainly became more entrenched because of this advertisement.
4 Personal communication, Michelle McLaurin, 8 December 1998.
5 Personal communication, Matthew Dailey, 24 January 1999.
6 National Public Radio, 30 January 1997, *All Things Considered* (transcript taken from Broadcast News database, 1998, by Research Publications International, Woodbridge, CT).
7 CNN, 22 June 1999, *Financial News* (Broadcast News transcripts).
8 Personal communication, Unknown, 22 August 2005.
9 Personal communication, Michelle McLaurin, 14 February 1999.
10 Personal communication, Janet Wiles, November 1998.
11 Personal communication, Michael Sharpe, 17 January 1999.
12 Personal observation from the movie *God Said Ha!* by Julia Sweeney.
13 ABC, 8 February 1999, *Good Morning America* (Broadcast News transcripts).
14 Personal communication, Unknown, February 1999.
15 Personal observation, UCSD Bookstore advertisement, September 1998.
16 Personal observations, The Learning Smith, La Jolla, CA, 16 January 1999.
17 CNN, 18 August 1997, *Financial News* (Broadcast News transcripts).
18 Personal communication, Michelle McLaurin, after watching too much television, 19 January 1999.
19 CNN, 28 October 1998, *News* (Broadcast News transcripts).

20 Personal observation, sports reporter, WUSI in San Diego, 8 October 1998.
21 Unknown, *Treebank Corpus* (Marcus, Santorini and Marcinkiewicz, 1993).
22 Personal communication, Jennifer Utman, referring to someone trying to use a computer, 15 October 1998.
23 Personal communication, Jennifer Utman, after a job interview, 17 February 1999.
24 Unknown, *Treebank Corpus* (Marcus et al., 1993).
25 National Public Radio, 28 August 1997, *All Things Considered* (Broadcast News transcripts).
26 Personal communication, Unknown, 8 January 1999.
27 Personal communication, Mark Gruber, September 1999.
28 Personal observation, National Public Radio, Unknown, 20 August 1999, *What Do You Know?*
29 National Public Radio, 15 June 1995, *Weekly Edition* (Broadcast News transcripts).
30 Personal communication, Cordelia Gross-Martinez, 11 June 2005.
31 Personal communication, Michael McLaurin, 24 November 1999.
32 Personal observation, www.playcranium.com (accessed 12 December 2000).
33 Personal observation, seen in Madison, WI, 3 August 1998.
34 Personal observation, seen in Los Angeles, CA, 28 December 2002.
35 Personal observation, television advertisement, seen in Tampa, FL, 23 December 1998.
36 Personal observation, UCSD TV, seen in San Diego, 18 October 1998.
37 Personal observation, PBS, John Bauer, November 1999, *Charlie Rose Show*.
38 Personal communication, Ginger Laney, 24 December 1999.
39 Personal communication, Michael Sharpe, 10 January 1999.
40 National Public Radio, 16 August 1992, *Weekend Edition* (Broadcast News transcripts).
41 National Public Radio, 22 October 1995, *Weekend Edition* (Broadcast News transcripts).
42 National Public Radio, 13 July 1997, *Weekend Edition* (Broadcast News transcripts).
43 National Public Radio, 3 May 1992, *Weekend Edition* (Broadcast News transcripts).
44 National Public Radio, 9 July 1995, *Weekend Edition* (Broadcast News transcripts).
45 National Public Radio, 17 December 1995, *Weekend Edition* (Broadcast News transcripts).
46 A personal anecdote: In social gatherings I find it more impressive to tell people I am a neuroscientist rather than a mathematical modeler or a cognitive scientist. Consequently, non-academic friends or new acquaintances will occasionally ask about "stories" (i.e. science narratives) they heard about recently on television. For example, someone asked me about food additives and how they might upset your brain chemicals; someone else asked why neurosurgeons can't just take out half an adult's brain like they do for kids.
47 Personal observation, television advertisement seen in Irvine, CA, January 2004.
48 Personal observation, television advertisement seen in, Irvine, CA, 15 August 2004, during Olympic television coverage.
49 Personal communication, Cynthia Madden, 22 January 2002.
50 Personal communication, Carla Torres, 5 March 2002.
51 See, for example, the editorial, "Does Neuroscience Threaten Human Values?," *Nature Neuroscience* (1998) 1(7): 535–6, which reviewed a conference entitled "Neuroscience and the Human Spirit" sponsored by the Ethics and Public Policy Center.

References

Begley, S. (1995) "Gray Matters: New Brain-scanning Technologies Show Differences between Men and Women," *Newsweek* 125(13) (27 March): 48–54 (cover story).

Begley, S. (1996) "Your Child's Brain," *Newsweek* 127(8) (19 February): 54–9.

Begley, S. (1997) "How to Build a Baby's Brain," *Newsweek* 129(Spring-Summer): 28–32.

Bennett, M.R. and Hacker, P.M.S. (2003) *Philosophical Foundations of Neuroscience*. Malden, MA: Blackwell.

Bogdan, R.J. (1991) *Mind and Common Sense: Philosophical Essays on Commonsense Psychology*. Cambridge: Cambridge University Press.

Chang, K. (2000) "Simple Spinning Toy Poses a Mathematical Challenge," *New York Times* 25 April: Section F, p. 5.

Christensen, S.M. and Turner, D.R. (1993) *Folk Psychology and the Philosophy of Mind*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Christidou, V., Dimopoulos, K. and Koulaidis, V. (2004) "Constructing Social Representations of Science and Technology: the Role of Metaphors in the Press and the Popular Scientific Magazines," *Public Understanding of Science* 13: 347–62.

Churchland, P.M. (1981) "Eliminative Materialism and Propositional Attitudes," *Journal of Philosophy* 78: 67–90.

Churchland, P.M. (1995) *The Engine of Reason, the Seat of the Soul*. Cambridge, MA: MIT Press.

Churchland, P.M. (1998) "Folk Psychology," in *On the Contrary: Critical Essays, 1987–1997*, pp. 3–15. Cambridge, MA: MIT Press.

Churchland, P.M. and Churchland, P.S. (1996) "Future of Psychology, Folk and Scientific," in R.N. McCauley (ed.) *The Churchlands and their Critics*, Part IIA, pp. 219–21. Cambridge, MA: Blackwell.

Churchland, P.S. (1986) *Neurophilosophy: Toward a Unified Science of the Mind/Brain*. Cambridge, MA: MIT Press.

Clark, A. (1996) "Dealing in Futures: Folk Psychology and the Role of Representations in Cognitive Science," in R.N. McCauley (ed.) *The Churchlands and their Critics*, pp. 86–104. Cambridge, MA: Blackwell.

Coulson, S. and Oakley, T. (2000) "Blending Basics," *Cognitive Linguistics* 11: 175–96.

D'Andrade, R. (1987) "A Folk Model of the Mind," in N. Holland and N. Quinn (eds) *Cultural Models in Language and Thought*, pp. 112–48. Cambridge: Cambridge University Press.

Dennett, D. (1981) "Three Kinds of Intentional Psychology," in R. Healey (ed.) *Reduction, Time, and Reality*, pp. 37–61. New York: Cambridge University Press.

Dufresne, C. (1998) "While Most Athletes Possess Great Physical Skills, it's the Mind that Separates the Best from the Rest," *Los Angeles Times* 9 August: Section C, p. 1.

Dumit, J. (2004) *Picturing Personhood: Brain Scans and Biomedical Identity*. Princeton, NJ: Princeton University Press.

Duque-Fernandez, D. and Johnson, M.L. (2002) "Cause and Effect Theories of Attention: The Role of Conceptual Metaphors," *Review of General Psychology* 6(2): 153–65.

Emslie, C., Hunt, K. and Watt, G. (2003) "A Chip Off the Old Block? Lay Understandings of Inheritance among Men and Women in Mid-life," *Public Understanding of Science* 12: 47–65.

Eysenck, H.J. (2004) *Decline and Fall of the Freudian Empire*. New Brunswick, NJ: Transaction Publishers.

Fahrenberg, J. and Cheetham, M. (2000) "The Mind-Body Problem as Seen by Students of Different Disciplines," *Journal of Consciousness Studies* 7(5): 47–59.

Fauconnier, G. and Turner, M. (1998) "Conceptual Integration Networks," *Cognitive Science* 22(2): 133–87.

Fauconnier, G. and Turner, M. (2002) *The Way We Think: Conceptual Blending and the Mind's Hidden Complexities*. New York: Basic Books.

Fodor, J. (1987) "The Persistence of the Attitudes," in *Psychosemantics*, pp. 1–26. Cambridge, MA: MIT Press.

Gibbs, R.W. (1994) *The Poetics of Mind: Figurative Thought, Language, and Understanding*. New York: Cambridge University Press.

Goode, E. (1999) "Mozart for Baby? Some Say, Maybe Not," *New York Times* 3 August: Section F, p. 1.

Greenwood, J.D. (1991) *The Future of Folk Psychology: Intentionality and Cognitive Science*. New York: Cambridge University Press.

Guterl, F. (2002) "What Freud Got Right," *Newsweek* 140(20) (11 November): 50.

Hamel, G. (2001) "Take it Higher," *Fortune* 5 February: 169–70.

Hancock, L.N. (1996) "Why Do Schools Flunk Biology? Early Childhood Education and Learning," *Newsweek* 127(8) (19 February): 58–9 (cover story).

Hannan, B. (1993) "Don't Stop Believing: The Case Against Eliminative Materialism," *Mind and Language* 8(2): 165–79.

Hare, M., McRae, K. and Elman, J.L. (2004) "Admitting that Admitting Verb Sense into Corpus Analysis Makes Sense," *Language and Cognitive Processes* 19(2): 181–224.

Horgan, T. and Woodward, J. (1985) "Folk Psychology is Here to Stay," *The Philosophical Review* 94: 197–226.

James, C. (1999) "Cutups on Cable: Odd Ones In," *New York Times* 30 April: Section E, p. 1.

Kleinfield, N.R. (1999) "For Three Interns, Fatigue and Healing at Top Speed," *New York Times* 15 November: Section A, p. 1.

Knudsen, S. (2005) "Communicating Novel and Conventional Scientific Metaphors: A Study of the Development of the Metaphor of Genetic Code," *Public Understanding of Science* 14: 373–92.

Lakoff, G. (1987) *Woman, Fire, and Dangerous Things*. Chicago: University of Chicago Press.

Lakoff, G. and Johnson, M. (1980) *Metaphors We Live By*. Chicago: University of Chicago Press.

Lakoff, G. and Johnson, M. (1999) *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*. New York: Basic Books.

Lemonick, M.D. (1995) "Glimpses of the Mind," *Time* 146(3) (17 July): 44–52 (cover story).

Lemonick, M.D. (1997) "The Mood Molecule: Serotonin Drugs Treat Everything from Depression to Overeating," *Time* 150(13) (29 September): 74–81 (cover story).

Liakopoulos, M. (2002) "Pandora's Box or Panacea? Using Metaphors to Create the Public Representations of Biotechnology," *Public Understanding of Science* 11: 5–32.

Linde, C. (1987) "Explanatory Systems in Oral Life Stories," in N. Holland and N. Quinn (eds) *Cultural Models in Language and Thought*, pp. 343–66. Cambridge: Cambridge University Press.

Marcus, M., Santorini, B. and Marcinkiewicz, M.A. (1993) "Building a Large Annotated Corpus of English: The Penn Treebank," *Computational Linguistics* 19(2): 313–30.

McCauley, R.N. (1993) "Intertheoretic Reduction and the Future of Psychology," *Philosophy of Science* 53: 179–98.

Nash, J.M. (1997a) "Fertile Minds: From Birth, a Baby's Brain Cells Proliferate Wildly, Making Connections that May Shape a Lifetime of Experience," *Time* 149(5): 48–56 (cover story).

Nash, J.M. (1997b) "Addicted: Why Do People Get Hooked? Mounting Evidence Points to a Powerful Brain Chemical called Dopamine," *Time* 149(18) (5 May): 68–74 (cover story).

Nelkin, D. and Lindee, M.S. (1995) *The DNA Mystique: The Gene as a Cultural Icon*. New York: Freeman.

Pribram, K. (1971) *Languages of the Brain: Experimental Paradoxes and Principles of Neuropsychology*. New York: Brandon House.

Richards, M. (1996) "Lay and Professional Knowledge of Genetics and Inheritance," *Public Understanding of Science* 5: 217–30.

Rohrer, T. (2001) "Even the Interface is for Sale: Metaphors, Visual Blends and the Hidden Ideology of the Internet," in R. Dirven, C. Ilie and R.M. Frank (eds) *Language and Ideology: Cognitive Descriptive Approaches*, Vol. II, pp. 189–214. Amsterdam: John Benjamins.

Rohrer, T. (2004) "Race-baiting, Cartooning, and Ideology: A Conceptual Blending Analysis of Contemporary and WWII War Cartoons," in S. Greschonig and C.S. Sing (eds) *Ideologien Zwischen Luge und Wahrheitsanspruch*, Part C, pp. 189–214. Wiesbaden: Deutscher Unversitats-Verlag.

Rorty, R. (1980) *Philosophy and the Mirror of Nature*. Princeton, NJ: Princeton University Press.

Searle, J. (1984) *Minds, Brains, and Science*. Cambridge, MA: Harvard University Press.

Shapin, S. (1979) "The Politics of Observation: Cerebral Anatomy and Social Interests in the Edinburgh Phrenology Disputes," *The Sociological Review* Monograph No. 27, pp. 139–78.

Shaw, A. (2002) "It Just Goes against the Grain," *Public Understanding of Science* 11: 273–91.

Sontag, S.L. (1998) "Don't Forget the Addict's Role in Addiction," *New York Times* 4 April: Section A, p. 13.

Star, S.L. (1992) "The Skin, the Skull, and the Self: Toward a Sociology of the Brain," in A. Harrington (ed.) *So Human a Brain*: *Knowledge and Values in the Neurosciences*, pp. 204–28. Cambridge, MA: Birkhauser Boston.

Sterngold, J. (1999) "For all the TV Pilots, There's Just Not Enough Youth to go Around," *New York Times* 17 May: Section E, p. 1.

Stich, S.P. (1983) *From Folk Psychology to Cognitive Science: The Case Against Belief*. Cambridge, MA: MIT Press.

Strauss, N. (1999) "The Pop Life: Raiding Memory Lane," *New York Times* 3 November: Section E, p. 5.

Ten Eyck, T.A. (2005) "The Media and Public Opinion on Genetics and Biotechnology: Mirrors, Windows, or Walls?," *Public Understanding of Science* 14: 305–16.

Thompson, T. (1999) "Change of Place," *Washington Post Magazine* 20 June: W14.

Valenstein, E.S. (1998) *Blaming the Brain: the Truth about Drugs and Mental Health*. New York: Free Press.

Wilkes, K. (1993) "The Relationship between Scientific Psychology and Common Sense Psychology," *Synthese* 89: 15–39.

Wynne, B. (1992) "Misunderstood Misunderstanding: Social Identities and Public Uptake of Science," *Public Understanding of Science* 1: 281–304.

Wynne, B. (1993) "Public Uptake of Science: a Case for Institutional Reflexivity," *Public Understanding of Science* 2: 321–37.

Zimmer, C. (2004) *Soul Made Flesh: the Discovery of the Brain—and How it Changed the World*. New York: Free Press.

Author

Paul Rodriguez received his Ph.D. in Cognitive Science from University of California at San Diego in 1999 and is currently a research scientist in the Department of Cognitive Science and Research Imaging Center at the University of California at Irvine. His primary research is methodological issues in functional magnetic resonance imaging, learning and memory,

and mathematical modeling. This article combines the methodology of cognitive semantics, his interests in cognitive neuroscience, and trying to come to grips with the broad implications of explaining the mind. **Correspondence:** Department of Cognitive Science, University of California, Irvine, 5100 Social Science Plaza A, Irvine, CA 92697, USA, e-mail: pfrodrig@uci.edu