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Concepts in the Brain: Neuroscience, Embodiment, and Categorization

Joseph B. McCaffrey

Abstract

What does cognitive neuroscience contribute to our philosophical understanding of concepts? Over the past several decades, brain researchers have employed the tools of cognitive neuroscience (e.g. neuroimaging techniques such as fMRI) and neuropsychology (i.e. studying patterns of cognitive deficits resulting from brain injury) to probe the structure and function of the conceptual system. The results of this effort, which are often extremely surprising, raise more questions than they resolve. Brain research has invigorated age-old philosophical debates about the nature of concepts—such as whether concepts are perceptual representations—and generated new controversies about how conceptual knowledge is organized. In this essay, I examine three debates in the neuroscience of conceptual knowledge: whether concepts are embodied or couched in amodal representations, whether conceptual knowledge is organized according to evolved categories, and whether the brain has multiple conceptual systems. My purpose is not to resolve these debates—rather, I intend to show how many of the proposed solutions fail to accommodate the diverse range of data emerging from cognitive neuroscience. I am therefore skeptical that brain data alone will resolve these issues, but remain optimistic that neuroscience has much to contribute to philosophical accounts of concepts.

1. Introduction

In this article, I explore how cognitive neuroscience bears on philosophical debates about concepts. First, I lay the groundwork for my discussion by examining which debates about concepts are most likely to benefit from contact with cognitive neuroscience, broadly construed as the use of brain data to test hypotheses about human cognition. I propose that debates about the nature and acquisition of *conceptual knowledge*—e.g. debates about whether certain concepts are innate—are most amenable to data from cognitive neuroscience. I also introduce two of the tools by which cognitive neuroscientists study conceptual knowledge—functional neuroimaging studies and neuropsychology studies—and illustrate some important findings to date (section 2). Then (sections 3–5) I evaluate three debates about the nature and organization of conceptual knowledge: whether concepts are amodal or perceptual representations, whether the brain contains a unitary "semantic" or "conceptual" system, and whether certain conceptual categories (e.g. animal or shelter) are innate.[1] For each empirical debate, I highlight its philosophical significance and examine evidence for and against each position. My goal is not to answer these questions, but to clarify what is at stake and evaluate where each debate stands given current evidence from cognitive neuroscience. I conclude (section 6) by raising some general theoretical concerns about the use of brain data to test hypotheses about concepts.

2. This is Your Brain on Concepts

In this section, I briefly lay the groundwork for a critical examination of the neuroscience of concepts. First, I discuss which philosophical perspectives are most likely to benefit from taking cognitive neuroscience into account. Second, I demonstrate how two techniques—functional neuroimaging studies and neuropsychology studies—have been used to develop and test theories about concepts.

2.1. Concepts and Cognitive Neuroscience

What is a concept? Beyond the idea that concepts are the building blocks of thoughts (see Laurence and Margolis 1999), there is little consensus in the philosophical literature about what concepts are or what it means to have one. For some philosophers (e.g. Fodor 1975, Prinz 2002), concepts are literally the constituents of thoughts—viz., they are mental representations that are tokened when one thinks about certain things. On this view, when someone thinks "sloths are mammals," he or she tokens a mental representation that corresponds to the concept SLOTH.[2] For other philosophers (e.g. Dummett 1993, Brandom 2007) concepts are abilities rather than particular psychological entities. According to this view, having the concept SLOTH might involve the ability to recognize sloths, the ability to distinguish them from other animals, or the ability to draw certain inferences (e.g. "if x is a sloth, then x is furry and slow") about sloths. For yet others (e.g. Zalta 2001), concepts are abstract linguistic entities rather than mental ones.

1 Due to space limitations, there are a number of important issues, including the relationship between linguistic and conceptual capabilities that I will not discuss extensively in this paper.

2 For the rest of the essay, I will use small caps to name concepts.

Similarly, there is disagreement among philosophers about what a theory of concepts should accomplish. Machery (2009) argues that philosophical and psychological theories of concepts have distinct aims. According to Machery, philosophical theories of concepts (e.g. Fodor 1975) are typically intended to explain how people can have propositional attitudes, such as beliefs and desires, about particular referents. For instance, a philosopher might want to know how one can have thoughts about PARROTS as such rather than thoughts about BIRDS or ZOO DWELLERS or PLUMED THINGS. Or, a philosopher might want to explain the conditions under which two individuals can be said to possess the same concept PARROT (e.g. Fodor 2004). On the other hand, psychological theories of concepts (e.g. Carey 2009) are typically intended to explain cognitive phenomena such as learning, categorization, and inferential capabilities.

Given the diversity of philosophical approaches to concepts, there are bound to be difficulties in translating findings from neuroscience to philosophy. For example, if concepts are not entities that are tokened in the head during bouts of cognition (particularly if they are viewed as abstract linguistic entities), then it might seem like a category mistake to think that brain scans can reveal much of interest about the nature of concepts. For the purposes of this essay, I am interested in *psychological* accounts of concepts—that is, I take concepts to be representations, bodies of knowledge, or abilities that are deployed when people think about, categorize, or make judgments about certain objects or states of affairs rather than the conditions under which people think about those objects *as such* or the conditions under which different people can be said to possess the same concept of x. Put succinctly, cognitive neuroscience might say something about people's *conceptual knowledge* of animals, such as how they reason about or identify them, but it is unlikely to reveal what constitutes the concept ANIMAL, if such a thing exists. Conceptual knowledge is the sort of thing that can be innate or acquired through experience; it is also the sort of thing for which it makes sense to ask: what *kind* of knowledge (i.e. whether that knowledge consists of prototypes, exemplars, etc.) does one possess about animals? Note that many of the debates I discuss in the paper are couched in terms of the representational theory of mind (see Laurence and Margolis 1999). While my discussion will inherit these terms, one need not subscribe to the representational theory of mind (or of concepts) to benefit from the discussion. For example, the debate about whether concepts are perceptual *representations* (see section 3) could easily be interpreted in terms of abilities.

Cognitive neuroscience uses brain data to test hypotheses about the nature of cognition. In the following sections, I explore how cognitive neuroscience bears on three philosophical debates about the nature of conceptual knowledge. First (sections 2.2 and 2.3), I introduce two of the main tools—neuropsychological studies, which involve observing patterns of deficits in patients with brain lesions and functional neuroimaging studies, which involve measuring metabolic activity in the human brain during cognitive tasks—by which cognitive neuroscientists study semantic or conceptual knowledge. After introducing these techniques, I illustrate some key findings so far. My discussion of these techniques and findings is not comprehensive. First, there are many techniques, such as transcranial magnetic stimulation (see Pobric, Lambon Ralph and Jeffries 2009) and event related potentials (see Sim and Kiefer 2005) that I do not examine. Second, there are many methodological issues with the kinds of studies I do evaluate—e.g. whether subtraction is a warranted practice in neuroimaging—that I will not treat in detail. Finally, the findings I mention as "important" are by no means exhaustive; I only include those which are considered "classic" findings or which later bear on the debates I am interested in examining.

2.2. *Neuropsychology Studies*

Neuropsychology is the study of congenital or acquired cognitive deficits resulting from neuropathology (see Shallice 1988). One of the central practices in neuropsychology, which is considered an important source of data about the functional architecture of human cognition, is to identify dissociations between cognitive abilities. Dissociations are thought to provide evidence of distinct cognitive processes. For instance, if a patient has significant deficits in mathematical abilities, but relatively spared musical abilities, this suggests that different cognitive processes underlie music and mathematics. So-called "double dissociations" are widely held as the gold standard for distinguishing cognitive processes from one another (Shallice 1988). A double dissociation occurs when researchers isolate a patient population with deficits in cognitive ability A but not cognitive ability B and also a patient population that is impaired in cognitive capability B but not cognitive capability A.

Many different neuropsychological conditions cause deficits in semantic or conceptual abilities (for a review, see Mahon and Caramazza, 2009). Perhaps the most widely discussed phenomenon in neuropsychology is the existence of category-specific semantic deficits (see Warrington and Shallice 1984). That is, certain patients have an impaired ability to categorize, recognize, or recall facts about members of particular categories, such as fruits vegetables, or tools while members of other semantic categories remain mostly spared. Furthermore, several studies (e.g. Hillis and Caramazza, 1991) report a double dissociation between semantic performance for artifacts (i.e. tools, vehicles, and other man-made objects) and living things. In other words, some patients have category-specific semantic deficits for living things, such as an inability to recognize a picture of a duck or to categorize a duck as a bird, but mostly spared performance for artifacts while the opposite pattern is observed for other patients.

Additionally, some patients experience semantic deficits related to particular input or output modalities (i.e. deficits dependent on the way information is presented). For example, Beauvois (1982) reports that patients with optic aphasia exhibit semantic deficits related to objects that are presented visually; however, these patients do not exhibit semantic deficits when other modalities are probed. For instance, a patient with optic aphasia may be unable to name a watering can when shown a picture of one, but able to name a watering can placed in his or her hands. Optic aphasia is considered a *semantic* deficit rather than a strictly visual one because patients often exhibit naming and recall deficits while nonetheless demonstrating through other means that they can "see" the object in question. For example, some patients with optic aphasia are able to correctly pantomime how to use objects that, when presented visually, they cannot name (Coslett and Saffran 1992).

Finally, some neuropsychological patients experience generalized semantic deficits. Patients with semantic dementia, a rare clinical variant of frontotemporal dementia, exhibit a progressive loss of expressive vocabulary and difficulty naming, recalling facts about, or categorizing objects (Snowden, Goulding and Neary 1989). In semantic dementia, degeneration of the anterior temporal lobes causes progressively worsening semantic impairments while other cognitive abilities such as episodic memory and numerical cognition remain relatively intact until later stages of the disease (Garrard and Hodges 2000). Notably, semantic dementia affects some members of the various categories (e.g. some living things and some tools) that are impaired in category-specific semantic deficits. Furthermore, impairments in semantic dementia are highly multi-modal, affecting knowledge related to many different perceptual modalities (e.g. what something looks or sounds like) for each affected item. (Bozeat et al. 2000).

2.3. Neuroimaging Studies (fMRI)

Functional neuroimaging involves the use of biomedical imaging technologies to study neural activity in alert human participants. Neuroimaging is a one of the main tools of cognitive neuroscience, which seeks to localize cognitive functions to particular brain areas and to use brain data to test competing psychological hypotheses. Functional magnetic resonance imaging (fMRI), currently the most common form of neuroimaging in cognitive neuroscience, uses magnetic resonance properties to measure changes in blood oxygenation and flow in cerebral blood vessels during cognitive tasks (Aguirre 2003). The blood oxygen dependent (BOLD) response is usually averaged over several seconds of activity, in a particular set voxels (i.e. small cubes of brain that are a few millimeters in volume). That is, fMRI has a spatial resolution on the order of a few millimeters and a temporal resolution on the order of a few seconds (Aguirre 2003). Typically, neuroimaging researchers utilize a technique called cognitive subtraction, in which researchers subtract the BOLD signal in a matched control condition from the BOLD signal obtained during a cognitive task of interest, to isolate task relevant cognitive activity. For example, researchers might design a task comparison to isolate neural activity related to word comprehension from neural activity related to irrelevant factors such as seeing a word or pushing a button (see Amaro and Barker 2006).

There are two main ways of interpreting a task-related BOLD response in a set of voxels. In forward inference (see Henson, 2006), researchers infer that two tasks do or do not recruit the same cognitive processes based on BOLD response patterns. A neural dissociation occurs when two tasks elicit different patterns of BOLD activity while a neural association occurs when two tasks elicit similar patterns of BOLD activity. For instance, one might conclude on the basis of a BOLD dissociation that two tasks thought to recruit working memory actually recruit different psychological processes. In reverse inference (see Poldrack 2006), researchers infer that a task recruits some cognitive process based on a pattern of brain activity. For example, assume it is known that premotor cortex is involved in the preparation of motor movements. If some task elicits significant BOLD response from voxels in the premotor cortex, one might conclude that the task involves motor planning.

Several studies (e.g. Martin et al. 1996, Tettamanti et al. 2005) have used fMRI to explore where conceptual knowledge resides in the brain. The main finding (see Martin and Chao 2001) is that semantic or conceptual knowledge appears to be highly distributed throughout different parts of the brain—in other words, neuroimaging has failed to isolate a single “semantic region” of the brain. Instead, neuroimaging studies imply that different kinds of conceptual knowledge, such as nouns versus verbs or different noun categories, have different neural substrates. Martin and colleagues (1996), for example, report that knowledge about different semantic categories, such as tools versus living things, is implemented in different regions of cortex. Similarly, many studies (e.g. Mahon et al. 2009) report that noun concepts typically elicit BOLD signals in the so-called ventral visual stream (e.g. the lingual gyrus) while verb concepts tend to elicit BOLD signals in frontal and parietal regions associated with motor control (Tettamanti et al. 2005).

2.4. Summary

There is no consensus about what these findings from neuropsychology and functional neuroimaging suggest about the neural basis of conceptual knowledge. For example, some theorists (e.g. Mahon et al. 2009) think that the existence of category-specific semantic deficits, combined with the fact that thinking about particular semantic categories elicit BOLD signal in different brain regions, reflects an innate organization of semantic knowledge according to evolved categories. Other theorists (e.g. Barsalou 1999) take these results to imply that semantic knowledge resides in perceptual systems distributed throughout the brain and that concepts are a form of perceptual representation (see section 3). Yet others (e.g. Patterson, Nestor and Rogers 2007) think neuropsychological data suggests a unitary semantic system, but that neuroimaging studies have robustly failed to find it. In what follows, I examine how these results bear on three debates in the cognitive neuroscience of conceptual knowledge: whether concepts are "embodied" or perceptual (section 3), whether conceptual knowledge is innately organized by evolved categories such as animals and tools (section 4), and whether there is a single semantic or conceptual system (section 5). For each scientific debate, I highlight its significance for philosophical issues such as the nature of conceptual vehicles, the status of innate concepts, and debates about conceptual pluralism.

3. Perceptual Vehicles: Neuroscience and Embodiment

What are the vehicles of conceptual thought? That is, assuming that concepts are mental representations used in forming thoughts and other cognitive activities (e.g. categorization), what *kind* of representations are they? The British empiricists of the 17^{th} and 18^{th} centuries, such as John Locke (1632–1704) and David Hume (1711–1776), argued that the constituents of thought are mental images or reproductions of sensory experiences. According to this picture, mental images—which can be visual, auditory, tactile, etc.—are the constituents of thought and thinking is a form of perceptual simulation (see Prinz 2005). For instance, thinking about a PORCH SWING may involve conjuring an image of a PORCH SWING and verifying whether it possesses certain properties. On the other hand, a traditional view in cognitive science holds that concepts are amodal representations—viz., concepts are a different kind of representation than those used in sensory, motor, and affective processing. Amodal representations are often thought to be linguistic or language-like. For instance, Quillian (1967, see also Collins and Quillian 1969) postulated that in addition to perceptual abilities, humans possess a store of propositional semantic knowledge organized into categorical (e.g. ROBINS ARE BIRDS) and feature-based (e.g. ROBINS HAVE WINGS) information.

Recently, neo-empiricism, the idea that concepts are embodied or grounded in perceptual capacities, has experienced a major revival in philosophy (e.g. Lakoff and Johnson, 1999, Prinz 2002, 2005) and cognitive science (e.g. Barsalou 1999, 2008). Neo-empiricists typically endorse what Weiskopf (2007) calls the *perceptual vehicles thesis*, which holds that concepts are perceptual (e.g. sensory, motor, affective, tactile) representations.[3] But what makes a representation perceptual? According to Prinz, a representation is perceptual if: 1) it is proprietary to a perceptual system, or 2) it shares the representational code of such a system (2002, 119). Therefore, concepts are perceptual representations if they are implemented by one or more perceptual system—e.g. perhaps comprehending the concept CORKSCREW involves representations that reside in motor regions of the brain—or if they are sufficiently *like* the representations those systems employ. For example, imagine that visual representations have two properties: they can be rotated and surface information is more accessible than internal information (e.g. it is easier to imagine the outside of a sphere than the inside). If the concept WALLABY—i.e. whatever mental representation permits someone to categorize or draw inferences about wallabies—shares these properties, it is likely a perceptual representation. However, unlike the British empiricists, neo-empiricists (see Prinz 2005) do not hold that concepts as mental images *per se*.

Neo-empiricists cite a wide range of evidence from cognitive psychology and

3 As Weiskopf (2007) notes, the perceptual vehicles thesis comes in different strengths. The strongest form is committed to the notion that all conceptual knowledge is couched in perceptual representations.

cognitive neuroscience in support of embodied concepts (Lakoff and Johnson 2005, Barsalou 2008). This evidence is typically geared toward showing: 1) that conceptual knowledge is localized in neural systems involved in perception and 2) that conceptual knowledge is organized or processed in a similar manner to perceptual memory (McCaffrey forthcoming). Neo-empiricists frequently invoke neuroimaging studies to support the claim that conceptual knowledge is localized in perceptual brain areas. For instance, Martin and colleagues (1996) conducted an fMRI study in which participants were instructed to name members of different categories. Martin and colleagues found that naming living things evoked differential BOLD responses in classically "visual areas" (e.g. parts of the ventral visual stream) while naming tools and other manipulable objects evoked responses in "motor" areas such as premotor cortex.

Neuroimaging studies that explore where conceptual knowledge is located are intended to support the *perceptual vehicles thesis* in one of two ways. First, some studies rely on the previous *functional attribution* of certain regions as "perceptual" (i.e. a form of reverse inference). For instance, Tettamanti and colleagues (2005) argue that verb comprehension selectively elicits BOLD response in frontal and parietal circuits known to be involved in motor control. On the other hand, some studies attempt to show—via neural associations—that the *same areas* are involved in deploying perceptual capacities and conceptual knowledge. For example, Hauk, Johnsrude, and Pulvermüller (2004) argue that comprehending certain verbs, such as "to kick" or "to throw," recruits areas of premotor cortex that are involved in performing the relevant action (i.e. actually kicking or throwing).

However, the inference from BOLD responses to perceptual vehicles can be challenged on methodological grounds (see Machery 2007 for a review). One problem with the idea that *the same* neural resources are used in deploying conceptual knowledge and perception or perceptual simulation is that fMRI studies often implicate regions close, but not identical, to the perceptual abilities on which those concepts are supposed to rely (Rugg and Thompson Schill 2011). For example, Willems and colleagues (2009) observed neural dissociations when participants were prompted to read a verb (e.g. to jump) or to imagine performing the appropriate action (e.g. jumping). These BOLD dissociations suggest that simulation and comprehension do not rely on one and the same neural resources. Therefore, support for neo-empiricism from neuroimaging relies on establishing that conceptual tasks elicit BOLD response in "perceptual" regions. There are two problems with assuming that activation in perceptual regions during conceptual tasks implies that concepts are stored or implemented in perceptual regions. First, Anderson (2010) and others have recently argued that brain areas are often re-deployed in service of quite different cognitive processes. For example, the insula is implicated in several different abilities such as taste, working memory, and disgust reactions. Some of these abilities are perceptual while others are not. The presence of multi-functionality (see Poldrack 2006) makes it problematic to infer that activity in a given brain area under different task conditions reflects the recruitment of the same cognitive process. Second, even if the BOLD responses observed in these studies reflect perceptual processing, several theorists (e.g. Machery 2007, Mahon and Caramazza 2008) have recently argued that fMRI lacks the temporal resolution needed to distinguish genuine semantic access (e.g. accessing one's concept of HAMMER) from spreading activation related to action preparation (e.g. thinking about swinging a hammer) or other cognitive processes. This is because cognitive processes can occur rapidly (e.g. hundreds of milliseconds) while fMRI typically aggregates the BOLD signal over several seconds of activity.

Neo-empiricists also appeal to neuropsychology studies to support the *perceptual vehicles thesis*. Warrington and Shallice (1984) explain the existence of category-specific semantic deficits by postulating that certain perceptual modalities (e.g. motor control or audition) are more important for identifying and reasoning about members of perceptual categories (e.g. tools). Several more recent studies (e.g. Martin et al. 1996) report that lesions in visual cortex often result in semantic deficits related to natural categories (e.g. plants and animals) while lesions in motor cortex more commonly result in semantic deficits related to artifacts. In support of this view is the fact that patients with deficits specific to natural categories also often exhibit visual deficits such as visual agnosia (Kiefer and Pulvermüller 2012). According to Kan and colleagues these findings suggest that, "conceptual knowledge is distributed across distinct attribute domains such as vision, touch, and action" (2003, 525). In other words, neo-empiricists hold that conceptual knowledge: 1) is distributed throughout sensory and motor cortices of the brain and 2) that semantic categories are organized according to perceptual features.

However, neuropsychology does not provide unequivocal support for neo-empiricism. According to McCaffrey (forthcoming, see also McCaffrey and Machery 2012), the neuropsychological disorder semantic dementia is problematic for the neo-empiricist account of how conceptual knowledge is organized in the brain. First, in semantic dementia, circumscribed damage to the anterior temporal lobes results in semantic deficits that cut across the different categories that are impaired in category-specific semantic deficits (Garrard and Hodges 2000). That is, semantic dementia patients exhibit impairments for *some* animals and *some* tools while other members of those categories are spared. Second, for each impaired concept, patients exhibit highly multi-modal (e.g. visual, tactile and auditory) semantic deficits (Bozeat et al 2000). For example, a patient with an impaired concept of COW might be unable to recognize a cow on sight or to recall information about a cow upon hearing "moo." This "modality-general, item specific" (McCaffrey and Machery 2012) pattern of semantic deficits violates neo-empiricist predictions about the neural basis of conceptual knowledge. If different semantic categories are distributed throughout different perceptual regions of the brain, then lesions should cause category-specific deficits, deficits that disproportionately affect certain modalities, or interactions between category member and impaired modality. In semantic dementia, none of these patterns hold; instead, patients experience category-general, multi-modal semantic deficits. Some researchers, such as Patterson, Nestor and Rogers (2007) take the pattern of impairments in semantic dementia to suggest that the anterior temporal lobes comprise an amodal hub for conceptual knowledge.

Several replies are available to the neo-empiricist. First, Fadiga and Pulvermüller (2010) argue that perhaps semantic knowledge is organized into multiple perceptual *circuits* that happen to converge near the anterior temporal lobes. According to this view, semantic dementia reflects damage to multiple perceptual circuits rather than damage to a unified store of conceptual knowledge. An interesting consequence of the idea that semantic dementia affects multiple perceptual circuits is that as the disease progresses, patients should experience deficits associated with additional categories or additional modalities. While this is not the pattern currently observed in longitudinal data (Garrard and Hodges 2000), more research is needed. Another reply is that the anterior temporal lobes may be causally involved in deploying conceptual knowledge, which nevertheless consists of perceptual representations distributed throughout the brain (see Weiskopf 2007 for a discussion of this strategy). This reply suggests an important lesson for discussions about conceptual vehicles: too often data about *where* conceptual knowledge is implemented has been taken to bear on the nature of those vehicles. For example, neo-empiricists think that the distributed nature of semantic knowledge lends support to perceptual vehicles while critics reply that a unified conceptual hub suggests amodal vehicles. However, since it is possible that the brain contains a distributed set of amodal representations or centralized store of perceptual ones, theorists will need to develop novel hypotheses that explain *how* conceptual processing occurs.

4. Concept Nativism and the Domain Specific Hypothesis

Where do our concepts arise from? In the 17th and 18th centuries, rationalists and empiricists fiercely debated whether the mind contains innate "ideas" or concepts. According to the empiricists, all concepts are derived from sensory experience. On the other hand, rationalists such as René Descartes (1596–1650), argued that many concepts—particularly mathematical and logical ones—are present in the mind *a priori* or prior to experience while others are acquired through contact with the world.[4] Concept nativism, the thesis that certain conceptual knowledge is innate, remains a lively issue in philosophy and cognitive science (see Cowie 1999, Carey 2009). Many psychologists (e.g. Mandler 1992, Barsalou 1999) deny the existence of innate conceptual knowledge and consider perceptual learning mechanisms sufficient to account for the origin of concepts. Others (e.g. Carey 2009) maintain that humans possess an innate repertoire of conceptual knowledge.

There are important similarities and differences between debates about concept nativism in philosophy and psychology. One similarity is that debates in both fields center on the acquisition of primitive concepts (Weiskopf 2008). Most theorists agree that humans frequently learn new concepts—e.g. TURDUCKEN—by combining existing ones—TURKEY, DUCK, CHICKEN and so forth. But, on pain of regress, conceptual recombination cannot explain how humans acquire their first concepts; therefore, at issue is how humans acquire new primitive concepts—viz., those which are not merely combinations of existing ones. Concept nativists hold that the mind contains a (potentially sizeable) stock of innate primitive concepts while concept empiricists deny this assertion.[5] However, a difference between philosophical and psychological approaches to concept nativism is that while many philosophers (e.g. Fodor 1975, 1981) think that certain adult lexical concepts—e.g. an adult's concept of BEAUTY or DOG—are innate, most concept nativists in psychology (e.g. Carey 2009) propose that primitive concepts are only found early in development. For instance, Carey (2009) argues that infants possess innate conceptual

4 I do not intend to imply that *a priori* knowledge in the early modern tradition is coextensive with innate knowledge (it is not, as while Descartes viewed certain concepts as innate Kant denied the existence of innate representations), only that disputes about innate knowledge were part of the debate between rationalists and empiricists (see Kitcher, 1980 for an excellent review).

5 It is worth noting that empiricist and nativist positions come in different strengths—for example, some empiricist theories deny the existence of innate concepts altogether while others merely argue that the stock of innate concepts is extremely limited (see Laurence and Margolis 1999).

knowledge in domains such as folk physics (i.e. how objects move in the world) and folk biology (i.e. what living things are and how they behave). However, this does not entail that any adult lexical concept—e.g. an adult's concept of DOG—is itself innate.

To illustrate the idea of innate primitive concepts, consider Setoh, Baillargeon, and Gelman's (2013) report that young infants have expectations about animals. Using a gaze-length paradigm, Setoh and colleagues (2013) found that eight-month-old infants were "surprised" when "animals" (i.e. objects that displayed characteristic animate movements) turned out to be hollow. This implies that young infants possess rudimentary knowledge about animals. Note that Setoh and colleagues do not claim that the expectation that animals have insides is innate (perhaps infants form this expectation through perceptual learning), only that it emerges surprisingly early in development. Nevertheless, the study serves as a good example of what counts as primitive conceptual knowledge and highlights an important point about "innateness." Typically, concept nativists think of innate concepts as those which—resonating with Samuels' (2002) conception of innateness in cognitive science—are *present in the absence of learning*. In short, concept nativism is committed to the existence of innate primitive concepts that serve as the precursors of further conceptual development; often, these concepts are specific to particular cognitive domains such as theory of mind or folk biology.

How does cognitive neuroscience bear on concept nativism? According to Mahon and Caramazza (2009), the best explanation of category-specific semantic deficits is that semantic information is organized in the brain according to categories such as artifacts and living things. Furthermore, the dissociable semantic categories are structured in ways that plausibly have evolutionary significance—for example, the ability to rapidly identify foods, tools, animals, and so forth may have conferred a selective advantage on early hominids (Caramazza and Shelton 1998). The so-called "domain-specific hypothesis" holds that conceptual knowledge in the brain is organized according to evolved object categories (Mahon and Caramazza 2009). The core commitment of the domain specific hypothesis is that different parts of the brain are innately specialized for particular semantic categories. On the other hand, empiricists (Warrington and Shallice 1984, Kan et al. 2003) hold that the organization of semantic categories in the brain arises from privileged relationships between particular perceptual modalities and particular semantic categories during development. For instance, many neuroscientists (e.g. Martin and Chao 2001) think the ventral visual stream is disproportionately involved in acquiring knowledge about living things.

Both empiricists and nativists agree that categorical knowledge (or access to it) is distributed throughout the brain and that this explains the existence of category-specific semantic deficits. Proponents of the domain specific hypothesis argue that neuropsychological studies (e.g. Farah and Rabinowitz 2003) and neuroimaging studies (e.g. Mahon et al. 2009) suggest that this pattern of brain organization is innate over empiricist alternatives. In an influential neuropsychological study, Farah and Rabinowitz (2003) report a case in which a patient (here called A) experienced bilateral occipital and occipitotemporal brain lesions at one year of age due to cerebral artery infarction. At the age of sixteen, A exhibited a category-specific semantic deficit for living things in addition to suffering from some degree of object agnosia and prosopagnosia (difficulty recognizing visually presented objects and faces, respectively). Farah and Rabinowitz found that A's semantic performance: 1) was better explained by a deficit for living things rather than stimulus familiarity or complexity and 2) was significantly impaired for questions probing both visual and non-visual knowledge of living things, but remained near control levels for various artifacts on both types of question. That is, A exhibited semantic deficits for living things when asked both questions about visual features—e.g. Do ducks have beaks? (my example)—and non-visual features—e.g. Is peacock served in French restaurants? (Farah and Rabinowitz 2003). Farah and Rabinowitz (2003, 402) argue that because there is no interaction between category (living things) and modality (visual features) as empiricists predict, this suggests the distinction between living and nonliving things "is explicitly encoded in the genome, along with a similarly explicit anatomical specification for the knowledge of living things."

There are at least two problems with Farah and Rabinowitz's (2003) interpretation that A's deficits reflect early damage to a neural substrate innately specialized for knowledge of living things. First, the fact that there is no apparent interaction between category and visual modality in A's impairments does not imply that the category of living things is innate. Farah and Rabinowitz (2003) seem to implicitly assume that the fact that A's brain lesions occurred early in life suggest that the adult organization of semantic information in the brain is innate. However, that A's deficits are perfectly compatible with early damage to a learning mechanism that is typically involved in developing categorical knowledge of living things. Second, Kiefer and Pulvermüller (2012) argue that A's performance is actually compatible with the idea that visual learning mechanisms guide the development of knowledge about living things. First, A did experience visual agnosia in addition to semantic deficits for living things. Second, the tasks that Farah and Rabinowitz classified as "non-visual"—e.g.

asking about whether peacocks are served in French restaurants—might actually rely on visual imagery—e.g. recalling what a peacock looks like or what it is like to be in a French restaurant. While Farah and Rabinowitz's (2003) findings are suggestive, they fail to provide strong evidence for the domain specific hypothesis.

Further support for the domain specific hypothesis derives from neuroimaging studies. Several theorists (e.g. Sim and Kiefer 2005) have reported brain areas with selectivity for specific semantic categories such as artifacts or living things. The so-called ventral visual stream—a large anatomical area considered important for object recognition—exhibits a "medial-to-lateral" bias in which the medial portion, such as the lingual gyrus, is preferentially responsive to tools and other manipulable objects while the ventral portion is preferentially responsive to living things (see Mahon et al. 2009 for a review). Mahon and colleagues (2009) conducted an fMRI study to determine if visual experience is necessary for developing this pattern of semantic localization in the ventral visual stream. To test this, Mahon and colleagues hypothesized that if visual experience is necessary for developing the medial-to-lateral bias, then a different pattern (i.e. a neural dissociation revealed by fMRI) should be observed between congenitally blind participants (i.e. individuals who are blind from birth) and sighted controls. Mahon and colleagues (2009) used fMRI to demonstrate that: 1) particular regions of interest in the ventral visual stream have the same BOLD response selectivity for living or nonliving things in both sighted and congenitally blind participants and 2) congenitally blind participants have the same medial-to-lateral pattern of semantic organization in the ventral visual stream. These results suggest that visual experience is not required for developing certain aspects of semantic organization in the brain.

Kiefer and Pulvermüller (2012) claim that these results fail to demonstrate innate categorical organization in the brain. Kiefer and Pulvermüller consider these findings consistent with the notion that congenitally blind participants construct the categories of living and nonliving things through tactile, auditory, and spatial experience. One possibility is that visual cortex in the blind becomes plastically recruited for tactile inputs. For example, other studies (e.g. Reich et al. 2011) demonstrate that the so-called visual word form area (VWFA) is preferentially activated when blind individuals "read" braille via touch. Another possibility is that blind individuals acquire differential knowledge of tools and animals through the fact that tools involve characteristic actions (e.g. swinging a hammer) and sounds (e.g. the clang of a hammer). Indeed, there are empiricist alternatives for explaining Mahon and colleagues' findings (2009) if the only requirement is that differential information between categories is somehow available to congenitally blind participants, but without specification of why the particular regions of interest that Mahon and colleagues studied would happen to be responsive to these differences (e.g. why certain regions in the ventral visual stream would be attentive to auditory or tactile information about living things in the blind) these replies seem *post hoc*.[6]

Additionally, Mahon and colleagues' (2009) fMRI study is charitably viewed as evidence against the specific empiricist hypothesis that visual experience plays a privileged role in structuring the organization of semantic knowledge in the brain rather than evidence for the claim that semantic categories are innately structured. While more work will be needed to demonstrate whether other perceptual learning mechanisms better account for the observed pattern of semantic organization in the brain, neither Mahon and colleagues' (2009) study nor Farah and Rabinowitz's (2003) study provides decisive evidence that conceptual knowledge is innately structured by evolved categories. The problem, as Kiefer and Pulvermüller (2012) note, is there is a wide range of alternatives available to the empiricist. Given the plurality of plausible perceptual learning mechanisms, there is no "magic bullet" (i.e. a single, decisive experiment) for determining whether the organization of semantic categories in the brain reflects innate constraints or is developed through perceptual experience. Therefore, disputes about concept nativism in neuroscience will revolve around whether the brain's organizational and functional properties arise from particular learning mechanisms.

5. Multiple Semantics and Conceptual Pluralism

What *kind* of mental representation (or psychological capacity) are concepts? Over the past several decades, psychologists have identified concepts with a number of cognitive constructs including propositional knowledge, prototypes, exemplars, and theories (see Laurence and Margolis 1999 for a review). Similarly, neo-empiricists have proposed that concepts are particular kinds of perceptual representations—for instance, Barsalou (1999) argues that conceptual knowledge consists of "perceptual symbols" or sensorimotor representations stored in long-term memory. These different theories of concepts have

6 Kiefer and Pulvermüller note that certain parts of the ventral visual stream are selective for auditory stimuli or spatial (i.e. volumetric) properties, but this does not explain why the particular regions of interest Mahon and colleagues (2009) measured were similarly biased for living versus nonliving things in all participants.

often been construed as competing alternatives (e.g. Komatsu 1992). However, as several theorists (Komatsu 1992, Machery 2009, Weiskopf 2009) have noted, there is no clear winner as each theory is good at accounting for certain aspects of cognitive performance and poor at accounting for others. For example, prototype theories are good at explaining *typicality* effects, such as why participants more readily identify robins as birds than penguins, but poor at explaining cases in which participants appear to reason from specific ideals or exemplars rather than central tendencies of categories (Weiskopf 2009).

Several philosophers (Machery 2009, Weiskopf 2009, Dove 2011) agree that the problem lies with the initial assumption that concepts are a particular kind of mental representation. Conceptual pluralism holds that there is no single kind of psychological entity, such as prototypes, that underlies all of our conceptual knowledge. Instead, many different kinds of psychological entities do the work (e.g. underlying category and similarity judgments) that concepts do in more traditional theories. According to conceptual pluralists, it is possible for an individual to possess several different concepts of the same thing. On a standard representationalist picture, thinking about a starfish involves tokening the concept STARFISH in one's head. In contrast, conceptual pluralists (Machery 2009, Weiskopf 2009) think one might possess several different concepts of STARFISH that are recruited for different cognitive tasks—for example, one might recruit a STARFISH EXEMPLAR to help verify whether "Starfish are spiny" is true and a STARFISH THEORY to help verify whether "Starfish are echinoderms" is true. In short, concept pluralism is committed to the claim that people categorize and reason using many different kinds of representations, and that none of these deserves the label of "concept" more than others.[7] Just as many philosophers have come to believe that concepts are not a single kind of psychological kind, many cognitive scientists (e.g. Warrington and Shallice, 1984) doubt that the brain contains a unitary conceptual system.

The multiple semantics hypothesis (see Beauvois 1982, Warrington and Shallice, 1984) holds that the brain contains multiple anatomically and functionally distinct semantic systems rather than a unitary store of conceptual knowledge. Support for the multiple semantics hypothesis derives from neuropsychological dissociations involving semantic access from different input modalities such

7 There are notable differences between recent interpretations of concept pluralism. For instance, Machery (2009) thinks that the kinds of representations used in cognition are so heterogeneous that the notion of a "concept" should be eliminated from psychology. On the other hand, Weiskopf (2009) thinks that "concept" is a useful theoretical notion because one can make interesting generalizations about the properties shared by the different representations that constitute conceptual knowledge.

as vision, hearing, and touch (see Beauvois 1982, Riddoch et al. 1988). For example, some patients are unable to comprehend a written word, such as "bear," but can identify the same word when hearing the letters "B.E.A.R." read out loud or when shown a picture of a bear (Riddoch et al. 1988, Plaut and Patterson, 2009). Patients with optic aphasia are frequently unable to name visually presented objects, such as a brush, but can often name these same objects when touching them. Additionally, these patients are often able to pantomime appropriate actions (e.g. brushing) when viewing those objects (Beauvois 1982, Coslett and Saffran 1992). The pattern of deficits observed in optic aphasia are confounding for theories in which different input modalities (e.g. touch and vision) are linked to different outputs (e.g. naming and pantomiming) via a unitary store of conceptual knowledge. The suggestion that visual inputs do not reach "conceptual knowledge" is problematic because patients access knowledge about object use via visual inputs. Furthermore, the deficit does not involve naming *per se* as patients can name objects when touching them. Proponents of the multiple semantics hypothesis take optic aphasia and related disorders to imply the existence of multiple semantic systems. For example, Beauvois (1982) characterizes optic aphasia as an inability of verbal semantics, which contains name information, to communicate with visual semantics, which contains visual information used in object recognition.

How does the multiple semantics hypothesis bear on conceptual pluralism? Conceptual pluralism holds that different *kinds* of conceptual knowledge are recruited in service of different cognitive tasks. The multiple semantics hypothesis holds that the brain contains multiple semantic systems that encode different bodies of knowledge about the same things. For example, the name of an object might be encoded in verbal semantics while past encounters with the object are encoded in visual semantics. It is worth noting that evidence of distinct neural systems does not necessarily provide evidence of distinct kinds of conceptual knowledge. For example, it is possible that while two different semantic systems encode different content (e.g. one system represents how to use an object while another represents other facts about it), conceptual knowledge in both systems is encoded in a common (e.g. pictorial or verbal) format. However, proponents of the multiple semantics hypothesis (e.g. Beauvois 1982) argue that neuropsychological conditions such as optic aphasia are best explained by appealing to distinct kinds of semantic information. Insofar as these interpretations are correct, evidence for the multiple semantics hypothesis provides *evidence* for conceptual pluralism.

The multiple semantics hypothesis faces two main problems. First, Caramazza and colleagues (1990) argue that neuropsychological impairments such as optic aphasia only suggest that certain inputs provide *privileged access* to certain conceptual contents—however this falls short of establishing the existence of multiple semantic systems or qualitatively different kinds of concepts knowledge. That is, deficits related to semantic access are compatible with the existence of a single conceptual system encoding different kinds of knowledge about an object (the name "eggplant," knowledge about how to cook with eggplants, botanical knowledge about eggplants, etc.) in which certain perceptual inputs provide privileged access to certain information. For example, perhaps it is easier to retrieve knowledge about how to cook an eggplant from touching it than seeing it, but easier to recall the name "eggplant" from looking at one. This alone would not entail that name information and culinary information are implemented in separate systems. Furthermore, Patterson and Plaut (2009) caution against interpreting neuropsychological dissociations as evidence for separate neural systems too readily. For example, Beauvois (1982) holds that optic aphasia and related disorders suggest the existence of multiple semantic systems including visual semantics, verbal semantics and (plausibly) tactile semantics. But patients with semantic dementia often experience deficits related to several modalities including verbal, visual, and tactile information about the same conceptual items (Bozeat et al. 2000). This suggests that while visual and verbal knowledge can sometimes be dissociated, they may also converge in healthy individuals. The lesson is that privileged access to semantic information from certain inputs does not itself imply the existence of distinct semantic systems.

To summarize, the multiple semantics hypothesis has significant implications for debates about conceptual pluralism. First, brain data may provide evidence for conceptual pluralism beyond that from cognitive psychology. Furthermore, evidence for multiple semantic systems in the brain might suggest different kinds of conceptual pluralism. Even if one admits that individuals possess several distinct kinds of conceptual knowledge, there is room for debate about what kinds of representations comprise this knowledge. Machery (2009) holds that prototypes, exemplars, and theories are leading candidates for different kinds of concepts. But other pluralistic theories carve concepts into kinds at different joints. For example, Dove (2011) argues that conceptual knowledge consists of two different sorts of representations: embodied or perceptual ones and linguistic or "disembodied" ones. Finally, while evidence of multiple semantic systems in the brain is relevant for debates about conceptual pluralism, it is unclear what justifies the inference from dissociations to distinct systems, or from distinct systems to different kinds of conceptual knowledge.

6. Conclusion

So what does cognitive neuroscience contribute to our philosophical understanding of concepts? Hopefully I have shown how brain research is relevant to several philosophical issues about concepts such as the nature of conceptual vehicles, whether cognition is embodied, the status of innate concepts, and debates about conceptual pluralism. There are several lessons to draw from this brief tour of concepts in the brain. First, while cognitive neuroscience and neuropsychology are a rich source of data about conceptual knowledge, many of the findings are controversial. One of the main ways that cognitive neuroscience can contribute to theories of concepts is to provide new phenomena to be explained. For example, the fact that patients can experience category-specific semantic deficits (Warrington and Shallice 1984) is challenging for a theory on which all concrete noun concepts are the same kinds of things. Similarly, when a recent fMRI (Mahon et al. 2009) study suggests that patients who are blind from birth have the same organization of semantic categories in the brain as sighted individuals, this is challenging for the theory that conceptual categories are constructed through perceptual learning mechanisms.

Second, my discussion suggests limitations for how brain data can be used to test competing theories about concepts. Frequently, researchers have used localization data—i.e. data about *where* some cognitive process likely occurs—as a proxy for claims about *how* conceptual processing takes place or what concepts are like. For example, in the debate about conceptual vehicles, some researchers (e.g. Patterson, Nestor and Rogers 2007) take the relationship between lesions in the anterior temporal lobes combined with the pattern of impairments in semantic dementia to suggest that concepts are amodal representations. However, the data may be compatible with some (but not all, as I have shown) accounts of embodied conceptual processing. Similarly, brain data may be limited in its ability to distinguish cognitive systems from one another. For example, neither BOLD dissociations for different semantic categories nor neuropsychological dissociations between retrieval from different input modalities clearly establish that categorical or feature-based knowledge is implemented in different systems distributed throughout the brain.

Finally, hypotheses about the nature of conceptual knowledge are often underdetermined by available brain data (see Machery, 2007). In many cases, the dialectic progresses from "bold" theories that make concrete predictions, but turn out to be wrong, and nuanced theories that accommodate the data equally well. For instance, a simple formulation of amodal concepts holds that the brain contains a unitary store of conceptual information encoded in a single format. However, it is difficult for such a theory to explain the inability of fMRI studies to converge on a single "conceptual area" of the brain or the existence of category-specific semantic deficits. An elegant empiricist theory (e.g. Barsalou 1999) holds that because thinking involves simulation, the same neural resources are used in perceptual and conceptual processing. However, this view does not explain fMRI dissociations between imagery and semantic comprehension (see Rugg and Thompson-Schill 2011). Often there is no decisive experiment for a given theory of concepts —instead, there are constellations of more local disputes. For example, there is probably no way for neuroscience to show that a certain concept is innate *per se*, only that it is not learned through some particular mechanism. Therefore, while cognitive neuroscience is a powerful tool for developing and testing theories of conceptual knowledge, philosophers should approach brain data with due caution and search for ways to link brain research with other philosophical and experimental approaches. Doing so will enrich debates about concepts in philosophy and cognitive science alike.

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Bibliography

Aguirre, A.K. 2003. Functional Imaging in Behavioral Neurology and Neuropsychology. In *Behavioral Neurology and Neuropsychology*, edited by Todd Feinberg and Martha Farah. New York, NY: McGraw Hill.

Amaro, E. Jr. and Barker, G.J. Study Design in fMRI: Basic Principles. *Brain and Cognition* 60(3): 220–232.

Anderson, M.L. 2010. Neural Reuse: A Fundamental Organizational Principle of the Brain. *Behavioral and Brain Sciences* 33: 245–313.

Barsalou, L.W. 1999. Perceptual Symbol Systems. *Behavioral and Brain Sciences* 22: 577–660.

Barsalou, L.W. 2008. Grounded Cognition. *Annual Review of Psychology* 59: 617–645.

Beauvois, M.F. 1982. Optic Aphasia: A Process of Interaction between Vision and Language. *Philosophical Transactions of the Royal Society of London B* 298: 35–47.

Bozeat, S., Lambon Ralph, M., Patterson, K., Garrard, P. and Hodges, J. 2000. Non-

Verbal Semantic Impairment in Semantic Dementia. *Neuropsychologia* 38: 1207–1215.
Brandom, R. 2007. Inferentialism and Some of its Challenges. *Philosophical and Phenomenological Research* 74(3): 651–676.
Caramazza, A. and Shelton, J.R. 1998. Domain-Specific Knowledge Systems in the Brain the Animate-Inanimate Distinction. *Journal of Cognitive Neuroscience* 10: 1–34.
Caramazza, A., Hillis, A.E., Rapp, B.C. and Romani, C. 1990. The Multiple Semantics Hypothesis: Multiple Confusions? *Cognitive Neuropsychology* 7(3): 161–189.
Carey, S. 2009. *The Origin of Concepts*. Oxford, UK: Oxford University Press.
Collins, A.M. and Quillian, M.R. 1969. Retrieval Time from Semantic Memory. *Journal of Verbal Learning and Behavior* 8: 240–247.
Coslett, H.B. and Saffran, E.M. 1992. Optic Aphasia and the Right Hemisphere: A Replication and Expansion. *Brain and Language* 43: 148–161.
Cowie, F. 1999. *What's Within? Nativism Reconsidered*. Oxford, UK: Oxford University Press.
Dove, G. 2011. On the Need for Embodied and Disembodied Cognition. *Frontiers in Psychology* 1: 1–13.
Dummett, M. 1993. *Seas of Language*. Oxford, UK: Oxford University Press.
Fadiga, L. and Pulvermüller, F. 2010. Active Perception: Sensorimotor Circuits as a Cortical Basis for Language. *Nature Reviews Neuroscience* 11: 351–360.
Farah, M.J. and Rabinowitz, C. 2003. Genetic and Environmental Influences on the Organization of Semantic Memory in the Brain: Is "Living Things" an Innate Category? *Cognitive Neuropsychology* 20: 401–408.
Fodor, J. 1975. *The Language of Thought*. Cambridge, MA: Harvard University Press.
Fodor, J. 1981. The Present Status of the Innateness Controversy. In *Representations: Philosophical Essays on the Foundations of Cognitive Science*, by Jerry Fodor. Cambridge, MA: Massachusetts Institute of Technology Press.
Fodor, J. 2004. Having Concepts: A Brief Refutation of the Twentieth Century. *Mind and Language* 19(1): 29–47.
Gallese, V. and Lakoff, G. 2005. The Brain's Concepts: The Role of the Sensory-Motor System in Conceptual Knowledge. *Cognitive Neuropsychology* 22:455–479.
Garrard, P. & Hodges, J. R. 2000. Semantic dementia: clinical, radiological and pathological perspectives. *Journal of Neurology*, 247: 409–422.
Hauk, O., Johnsrude, I. and Pulvermüller, F. 2004. Somatotopic Representation of Action Words in Human Motor and Premotor Cortex. *Neuron* 41: 301–307.
Henson, R. 2006. Forward Inference in Functional Neuroimaging: Dissociations versus Associations. *Trends in Cognitive Sciences* 10: 64–69.
Hillis, A.E. and Caramazza, A. 1991. Category-Specific Naming and Comprehension Impairment: A Double Dissociation. *Brain* 114: 2081–2094.
Kan, I.P., Barsalou, L.W., Solomon, K.O., Minor, J.K. & Thompson-Schill, S.L. 2003. Role of Mental Imagery in Property Verification Task: fMRI Evidence for Perceptual Representations of Conceptual Knowledge. *Cognitive Neuropsychology* 20: 525–540.
Kiefer, M. and Pulvermüller, F. 2012. Conceptual Representations in the Mind and Brain: Theoretical Developments, Current Evidence, and Future Directions. *Cortex*

48(7): 805–825.
Kitcher, P. 1980. A Priori Knowledge. *The Philosophical Review* 89(1): 3–23.
Lakoff, G. and Johnson, M. *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*. New York, NY: Basic Books.
Laurence, S. and Margolis, E. 1999. Concepts and Cognitive Science. In *Concepts: Core Readings*, edited by E. Margolis and S. Laurence, 3–81. Cambridge, UK: Cambridge University Press.
Machery, E. 2007. Concept Empiricism: a Methodological Critique. *Cognition* 104: 19–46.
Machery, E. 2009. *Doing Without Concepts.* Oxford, UK: Oxford University Press.
Mahon, B.Z. and Caramazza, A. 2008. A Critical Look at the Embodied Cognition Hypothesis and a New Proposal for Grounding Conceptual Content. *Journal of Physiology Paris* 102: 59–70.
Mahon, B.Z. and Caramazza, A. 2009. Concepts and Categories: A Cognitive Neuropsychological Perspective. *Annual Review of Psychology* 60: 27–51.
Mahon. B.Z., Anzellotti, S., Schwarzbach, J., Zampini, M. and Caramazza, A. 2009. Category-Specific Organization in the Human Brain Does not Require Visual Experience. *Neuron* 63: 397–405.
Mandler, J.M. 1992. How to Build a Baby: II. Conceptual Primitives. *Psychological Review* 99(4): 587–604.
Martin, A. and Chao, L. 2001. Semantic Memory and the Brain: Structures and Processes. *Current Opinion in Neurobiology* 11: 194–201.
Martin, A., Wiggs, C.L., Ungerleider, L.G. and Haxby, J.V. 1996. Neural Correlates of Category-Specific Knowledge. *Nature* 379(6566): 649–652.
McCaffrey, J. Forthcoming. Reconceiving Conceptual Vehicles: Lessons from Semantic Dementia. *Philosophical Psychology*.
McCaffrey, J. and Machery, E. 2012. Philosophical Issues about Concepts. *Wiley Interdisciplinary Reviews Cognitive Science* 3(2): 265–279.
Patterson, K., Nestor, P.J. and Rogers, T.T. 2007. Where Do You Know What you Know? The Representation of Semantic Knowledge in the Human Brain. *Nature Reviews Neuroscience* 8(12): 976–982.
Patterson, K. and Plaut, D. 2009. "Shallow Draughts Intoxicate the Brain:" Lessons from Cognitive Neuroscience for Cognitive Neuropsychology. *Topics in Cognitive Sciences* 1: 39–58.
Pobric, G., Jeffries, E. and Lambon Ralph, M.A. 2009. Conceptual Knowledge is Underpinned by Temporal Pole Bilaterally: Convergent evidence from rTMS. *Cerebral Cortex*, 19(4): 832–838.
Poldrack, R. 2006. Can Cognitive Processes be Inferred from Neuroimaging Data? *Trends in Cognitive Sciences* 10(2): 59–63.
Prinz, J.J. 2002. *Furnishing the Mind: Concepts and Their Perceptual Basis.* Cambridge, MA: Massachusetts Institute of Technology Press.
Prinz, J.J. 2005. The Return of Concept Empiricism. In *Handbook of Categorization in Cognitive Science*, edited by Henri Cohen and Claire Lefebvre. New Jersey: Elsevier.
Quillian, M.R. 1967. Word Concepts: A Theory and Simulation of Some Basic Semantic Capabilities. *Behavioral Science* 12: 410–430.

Reich, L., Szwed, M., Cohen, L. and Amedi, A. 2011. A Ventral Stream Reading Center Independent of Visual Experience. *Current Biology* 21:363–368.

Riddoch, M.J. Humphreys, G.W., Coltheart, M. and Funnell, E. 198. Semantic Systems or System? Neuropsychological Evidence Re-Examined. *Cognitive Neuropsychology* 5: 3–25.

Rugg, M.D. and Thompson-Schill, S.L. 2011. Moving Forward with fMRI Data. *Perspectives on Psychological Science* 8(1): 84–87.

Samuels, R. 2002. Nativism in Cognitive Science. *Mind and Language* 17(3): 233–265.

Setoh, P., Wu, D., Baillargeon, R. and Gelman, R. 2013. Young Infants Have Biological Expectations about Animals. *Proceedings of the National Academy of Sciences* 110(40): 15937–15942.

Shallice, T. 1988. *From Neuropsychology to Mental Structure*. Cambridge, UK: Cambridge University Press.

Sim, E.J. and Kiefer, M. 2005. Category-Related Brain Activity to Natural Categories is Associated with Retrieval of Visual Features: Evidence From Repetition Effects During Visual and Functional Judgments. *Cognitive Brain Research* 24: 260–273.

Snowden, J.S., Goulding, P.J. and Neary, D. 1989. Semantic Dementia: A Form of Circumscribed Cerebral Atrophy. *Behavioral Neurology* 2(3): 167–182.

Tettamanti, M., Buccino, G., Saccuman, M.C., Gallese, V., Danna, M., Scifo, P., Fazio, F., Rizzolati, G., Cappa, S.F. and Perani, D. 2005. Listening to Action-Related Sentences Activates Fronto-Parietal Motor Circuits. *Journal of Cognitive Neuroscience* 17(2): 273–281.

Warrington, E.K. and Shallice, T. 1984. Category Specific Semantic Impairments. *Brain* 107: 829–953.

Weiskopf, D. 2007. Concept Empiricism and the Vehicles of Thought. *Journal of Consciousness Studies* 14(9–10): 156–183.

Weiskopf, D. 2008. The Origins of Concepts. *Philosophical Studies* 140(3): 359–384.

Weiskopf, D. 2009. The Plurality of Concepts. *Synthese* 169: 145–173.

Willems, R.M., Toni, I., Hagoort, P. and Casasanto, D. 2009. Neural Dissociations between Action Verb Understanding and Motor Imagery. *Journal of Cognitive Neuroscience* 22(10): 2387–2400.

Zalta, E. 2001. Fregean Senses, Modes of Presentation, and Concepts. *Philosophical Perspectives* 15: 335–359.

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