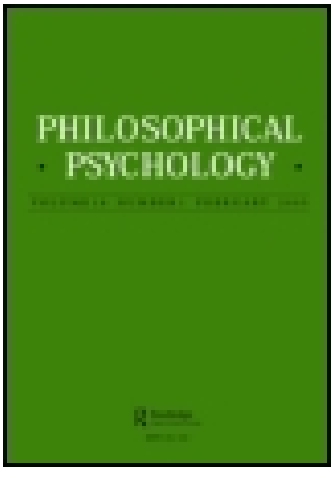

Philosophical Psychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/cphp20

Reconceiving conceptual vehicles: Lessons from semantic dementia

Joseph McCaffrey

Published online: 24 Jan 2014.

To cite this article: Joseph McCaffrey (2014): Reconceiving conceptual vehicles: Lessons from semantic dementia, Philosophical Psychology, DOI: 10.1080/09515089.2013.827561

To link to this article: http://dx.doi.org/10.1080/09515089.2013.827561

Philosophical Psychology, 2013
http://dx.doi.org/10.1080/09515089.2013.827561

Routledge
Taylor & Francis Group

Reconceiving conceptual vehicles: Lessons from semantic dementia

Joseph McCaffrey

What are the vehicles of conceptual thought? Recently, cognitive scientists and philosophers of psychology have developed quite different theories about what kinds of representations concepts are. At one extreme, amodal theories claim that concepts are representations whose vehicles are distinct from those used in perceptual processes. At the other end of the spectrum, neo-empiricism proposes that concepts are perceptual representations grounded in the mind's sensory, motor, and affective systems. In this essay, I examine how evidence from the neuropsychological disorder semantic dementia bears on philosophical debates about the nature of conceptual vehicles. I argue that the pattern of deficits in semantic dementia undermines recent neo-empiricist predictions about where and how conceptual knowledge is organized in the brain. I do not intend my analysis of semantic dementia to wholly discredit neo-empiricism; instead, I draw lessons for future theorizing about conceptual vehicles.

Keywords: Concept Empiricism; Neuropsychology; Philosophy; Semantic Dementia

1. Introduction

What are the vehicles of conceptual thought—namely, assuming that concepts are representations, what kinds of representations are they? A traditional view in cognitive science and philosophy of psychology asserts that concepts are amodal representations whose vehicles are distinct from those of the representations used in sensory, motor, and affective processing.[1] Recently, the tides have turned in favor of neo-empiricism, which proposes that concepts share the vehicular properties of perceptual representations (Barsalou, 1999, 2008; Gallese & Lakoff, 2005; Lakoff & Johnson, 1999; Prinz, 2002, 2005). The thesis that concepts are perceptual representations has received a great deal of attention from both philosophers (Machery, 2007) and cognitive scientists (Kiefer & Pulvermüller, 2012) who are interested in what concepts are and what psychological capacities are involved in deploying them. Neo-empiricists

Joseph McCaffrey is a graduate fellow at the University of Pittsburgh.
Correspondence to: Joseph McCaffrey, University of Pittsburgh—History and Philosophy of Science, 4200 Fifth Avenue, Pittsburgh, PA 15260, USA. Email: jbmccaffrey@gmail.com

argue that evidence from cognitive psychology, cognitive neuroscience, and neuropsychology support perceptual vehicles (see Barsalou, 2008 for a review).

In this essay, I argue that research on the neuropsychological disorder semantic dementia undermines alleged support for neo-empiricism from neuropsychology. Several neo-empiricists (e.g., Barsalou, 2008; Cree & McRae, 2003; Kiefer & Pulvermüller, 2012; Martin, Wiggs, Ungerleider, & Haxby, 1996) think that the existence of category-specific semantic deficits suggests that conceptual knowledge is distributed throughout modality-specific regions of the brain and organized according to particular perceptual modalities. I contend that the distributed, modality-specific picture of how concepts are arranged in the brain fails to account for semantic dementia, which exhibits both modality-general and category-general semantic deficits. First, I examine how neuropsychology bears on recent debates about the nature of conceptual vehicles. Second, I illustrate how semantic dementia poses problems for the neo-empiricist. Lastly, I discuss where debates about conceptual vehicles stand given findings from neuropsychology. I do not intend my discussion to countenance a given theory of conceptual vehicles; instead, I hope my discussion will engender a search for more sophisticated theories.

2. Neo-Empiricism and Neuropsychology

2.1. The Debate about Conceptual Vehicles

Several philosophical accounts of representation (e.g., Crane, 2003, p. 136; Millikan, 1993) distinguish between the information that a representation contains (its content) and the characteristic way in which a representation conveys that content (its vehicle). Sentences and pictures are examples of vehicles that (on the traditional view) can be used to convey the same content, For instance, a picture of a dog and the word 'dog' may be two different vehicles for the same content, DOG. Both amodal theorists and neo-empiricists believe that concepts are mental representations of some kind; however, they disagree about the nature of the vehicles in which these representations are couched. Neo-empiricists think that concepts are comprised of the same kind of representations (e.g., mental images and motor simulations) that various perceptual systems deploy. On the other hand, amodal theorists, who have traditionally identified concepts with linguistic representations, think that concepts are comprised of different kinds of representations than those involved in perception.

Many neo-empiricists endorse what Weiskopf (2007) calls the *perceptual vehicles thesis*. In its strong, global form, the perceptual vehicles thesis states that all concepts are wholly perceptual—that is, all of our conceptual knowledge consists solely of perceptual representations.[2] Before discussing how neuropsychology is intended to support the perceptual vehicles thesis, it is worth spelling out how the thesis is formulated. What does it mean to say that all conceptual content is couched in perceptual vehicles? The British empiricists of the seventeenth and eighteenth centuries developed a view that the vehicles of thought are mental images. On this view, concepts are perceptual because, on introspection, they are images or reproductions of sensory perceptions.

Neo-empiricists have developed a more subtle view: concepts can be perceptual even if thinking does not require mental imagery per se. Philosopher Jesse Prinz, a prominent neo-empiricist, proposes that a representation is perceptual if it is: 1) proprietary to a perceptual system or 2) shares the representational code of such a system (2002, p. 119).

I will unpack Prinz' proposal a bit. First, a representation is perceptual if it is contained within a perceptual system. For instance, the retinotopic maps of early visual cortex count as perceptual because they are part of a system that (at least on a widespread, rough-and-ready view) is solely and directly involved in sensation (i.e., encoding visual information from the retina). But not all representations involved in concept use will reside in particular perceptual systems—for instance, they may reside in higher-level association cortex (Weiskopf, 2007). In this case, a representation is perceptual if it shares the representational codes (i.e., vehicular properties) of representations found in perceptual systems. A simplified example will illustrate the point. Suppose that the visual system encodes memories of objects as three-dimensional images that can be rotated. The facts that visual memories are images, can be rotated, and are three-dimensional are vehicular properties. If another representation, say one's concept DOG, shares these vehicular properties (e.g., it is an image that can be rotated), then it too counts as perceptual.

Put succinctly, evidence (see, for example, Keifer & Püllermuller, 2012) for neo-empiricism is frequently about either *where* conceptual knowledge resides or *how* conceptual knowledge is processed. True to Prinz' account, most studies in support of neo-empiricism are intended to show either: 1) that conceptual knowledge is localized to brain areas thought to be involved in perception or 2) that conceptual knowledge is processed in a similar manner to perceptual information. Typically, neo-empiricists appeal to neuroimaging studies (particularly fMRI studies) to support the claim that conceptual knowledge is located within perceptual systems. For instance, Kan, Barsalou, Solomon, Minor, and Thompson-Schill (2003) found that the retrieval of semantic information selectively recruits the left fusiform gyrus, a particular region of visual cortex.

On the other hand, neo-empiricists usually appeal to cognitive psychology to support the claim that conceptual knowledge is processed in a similar manner to perceptual information. In an influential example (Prinz, 2005), Borghi, Glenberg, and Kashak (2004) found that participants were quicker to verify that objects possess certain features when those features were more salient from a hypothetical adopted perspective. Participants told they were "washing a car," for example, were quicker to verify statements about external features like "cars have headlights" than internal features like "cars have seats," while the opposite was true of participants told they were "driving a car." The study suggests that participants rely on mental imagery when completing this property verification task.

Skeptics contend that data from cognitive psychology and cognitive neuroscience is far from decisive in favor of neo-empiricism (Machery, 2007; Mahon & Caramazza, 2008; McCaffrey & Machery, 2012). The main issue with neuroimaging studies is that just because a perceptual brain area is activated during conceptual tasks, this does not guarantee that such an area contains or implements certain kinds of conceptual

knowledge. One problem (Mahon & Caramazza, 2008) is that poor temporal resolution may render fMRI studies unable to distinguish between neural activity that *constitutes* conceptual knowledge and neural activity that *accompanies* conceptual knowledge (e.g., preparation for action). Another problem (Rugg & Thompson-Schill, 2013) is that neuroimaging studies of concept use often isolate areas close to, but not identical to, well-characterized perceptual regions. Similarly, there are important concerns about whether recent experiments in cognitive psychology support perceptual vehicles.[3] For instance, Machery (2007) claims that many of the tasks used by neo-empiricists prompt participants to deploy visual imagery; therefore, they are not informative of concept use in general. One might conclude, as McCaffrey and Machery (2012) do, that new sources of evidence are needed to advance the debate over conceptual vehicles.

2.2. Neuropsychology and Semantic Deficits

One promising source of evidence about conceptual vehicles is neuropsychology, the study of congenital and acquired cognitive deficits resulting from neuropathology. A number of theorists (e.g., Barsalou, 2008; Kiefer & Pulvermüller, 2012) think that neuropsychology supports the perceptual vehicles thesis. In order to evaluate this claim, I first examine how neuropsychology bears on debates about conceptual vehicles.

Neuropsychology studies patterns of deficits arising from neuropathology—these deficits are thought to reveal both information about the functional localization of cognitive processes in the brain (Yeo, Turkheimer, & Bigler, 1990) and information about the architecture (i.e., organization) of cognition (Shallice, 1988). Neuropsychological dissociations (patterns of what deficits do and do not arise from neuropathology) can be used to determine whether two cognitive capacities depend on one another. For instance, double dissociations (see Shallice, 1988 for a detailed discussion) occur when patients can exhibit deficits in either of two capacities without impairing the other. For instance, if one patient can recognize faces but not perform mathematical calculations while another patient can perform mathematical calculations but fail to recognize faces, this suggests that face recognition and numeric cognition rely on separate processes.

According to neo-empiricists, the existence of category-specific semantic deficits supports the perceptual vehicles thesis. Warrington and Shallice (1984) famously documented a double dissociation between competences in the semantic categories of artifacts versus living things—namely, following brain injury patients can exhibit deficits in either category while competence in the other category is intact. For example, a patient may exhibit an impaired ability to recognize various tools (e.g., hammers, scissors, washing machines, etc.) while demonstrating an intact understanding of living things. Furthermore, these category-specific semantic deficits frequently arise from lesions in perceptual brain areas.

Several studies (e.g., Cree & McRae, 2003; Martin et al., 1996) report that damage to primary motor cortex is correlated with deficits (e.g., difficulties recognizing pictures of objects or recalling facts about them) related to tools, vehicles, etc. while lesions in

visual cortex (typically the ventral visual stream) often cause deficits in knowledge of plants and animals. From these studies, neo-empiricists propose that, "conceptual knowledge is distributed across distinct attribute domains, such as vision, touch, and action" in the brain (Kan et al., 2003, p. 525). The basic idea is that conceptual categories are grounded in the perceptual modality that is most frequently used to interact with those categories. For example, if simulating characteristic movements constitutes our knowledge of a tool (e.g., imagining how to swing a hammer), then it makes sense that knowledge about tools is grounded in motor areas of the brain.

Category-specific semantic deficits suggest that different semantic categories (i.e., artifacts and living things) are processed at least somewhat distinctly. As Keifer and Pulvermüller (2012) note, this fact alone is not enough to support neo-empiricism as some amodal theories (Caramazza & Mahon, 2003) also predict that the mind contains different sorts of representations for distinct conceptual categories. Category-specific semantic deficits are taken to support the perceptual vehicles thesis because there is a perceived functional and anatomical link between particular perceptual modalities and particular conceptual categories. For instance, that damage to the ventral visual stream can selectively impair one's knowledge of living things (Martin et al., 1996) suggests an anatomical link between the modality of vision and the category of living things. In a similar vein, the co-occurrence of motor deficits (i.e., difficulties initiating and sustaining movements) and semantic deficits related to action verbs in patients with motor cortex lesions suggests a functional link between the modality of motor control and the category of action verbs (Bak et al., 2001). Neo-empiricists take these findings to demonstrate that conceptual knowledge is distributed throughout modality-specific regions of the brain and that conceptual categories are delineated by specific perceptual modalities. I call this the view *modal domain hypothesis.*

3. Semantic Dementia and Modal Domains

In this section, I argue that research on semantic dementia undermines the modal domain hypothesis, which proposes that conceptual knowledge is distributed through perceptual regions of the brain and that conceptual categories are individuated by particular perceptual modalities. To begin, I will outline two findings that would be surprising on the modal domain hypothesis. First, if conceptual knowledge is distributed over several modal systems in the brain, there is no reason why damage to a single locus would cause deficits across numerous conceptual categories. Second, if conceptual categories are functionally linked to specific perceptual modalities, it is unlikely that concepts will exhibit the same pattern of modality-specific degradation regardless of category.

Semantic dementia (SD) is a rare clinical variant of frontotemporal dementia exhibiting bilateral neurodegeneration of the anterior temporal lobes (hereafter, the "ATLs" understood bilaterally) and a progressive loss of productive and receptive knowledge about people and objections (Snowden, Goulding, & Neary, 1989). One of the main clinical features of SD is a striking decline in expressive vocabulary

accompanied by deficits in naming, recognizing, and recalling relevant information about objects across several noun categories. SD is of particular interest to cognitive scientists (e.g., Keifer & Pulvermüller, 2012) because damage to a circumscribed region of the brain causes patients to experience fairly selective damage to semantic processing; until the late stages of the disease, which resemble other forms of frontotemporal dementia, patients frequently have intact behavior, speech production, episodic memory, and numerous other cognitive abilities (Garrard & Hodges, 2000).

Semantic dementia degrades conceptual knowledge in a progressive, hierarchical (sensu Rosch, 1975) fashion. For instance, a patient may fail to identify a picture of an object as an exemplar of a more specific category (e.g., DUCK), but know that it is a member of a more general one (e.g., BIRD). As the disease progresses, the same patient may be almost completely unable to categorize the same exemplar (e.g., she might know that the picture depicts some sort of animal, but not a duck or a bird). Two main features of SD bear on the modal domain hypothesis. First, SD patients lose conceptual knowledge in a progressive manner that is nonetheless haphazard with regard to affected items and categories (Garrard & Hodges, 2000; Patterson, Nestor, & Rogers, 2007). SD patients experience degraded knowledge of items within multiple object categories while other items from those same categories are unimpaired. For instance, a SD patient may experience difficulties with the concepts CAR and PENGUIN while other items from those same categories (e.g., BOAT and SLOTH) remain intact barring further damage. The modal domain hypothesis, which holds that conceptual knowledge is distributed throughout modality-specific regions of the brain, does not predict that damage to a single brain area will cause some items from multiple conceptual categories to be affected while other items from those same categories are spared.

Second, SD patients experience highly cross-modal deficits related to particular concepts (Bozeat, Lambon Ralph, Patterson, Garrard, & Hodges, 2000). It is well documented that SD patients have trouble recognizing both the picture of an object and its name. For example, a SD patient may be unable to both comprehend the word 'blender' and recognize a picture of a blender. Additionally, SD patients tend to lose feature knowledge across several different modalities (e.g., visual, tactile, auditory, etc.) for affected concepts. For instance, a patient with SD who cannot identify a cow from its characteristic "moo" is also unlikely to recognize a cow on sight. Garrard and Carroll (2006) found that impairments in four types of feature knowledge across different modalities (sound, motion, color, and environmental context) were highly correlated with one another for impaired items.

These results, which are corroborated by a number of studies on cross-modal deficits in SD, including smell and touch-related object recognition (see Dilkina, Plaut, & McClelland, 2008 for a review), suggest that patients lose most if not all kinds of feature knowledge for impaired items. Crucially, there seems to be no effect of category on which modality-specific features (e.g., the appearance or sound of an object) are affected for specific items; instead, different perceptual features are uniformly impaired across different categories. The modal domain hypothesis predicts that certain perceptual modalities are more constitutive of certain conceptual categories than others. For instance, motor representations are thought to play an

enhanced role in recognizing artifacts while visual representations are thought to play an enhanced role in recognizing living things. Therefore, the modal domain hypothesis should predict an interaction between certain perceptual features and certain semantic categories.

To summarize, the modal domain hypothesis states that conceptual knowledge is distributed throughout various modality-specific regions of the brain. I claim that this proposal makes two predictions about patterns of neuropsychological deficits. First, because knowledge of different conceptual categories is purportedly implemented in distant regions throughout the cortex (e.g., visual cortex versus motor cortex), there is no reason why damage to a single brain area should cause deficits across numerous different conceptual categories (e.g., artifacts, living things, people, etc.) while the basic ability to retrieve conceptual knowledge remains intact.[4] Second, because conceptual categories (e.g., TOOL) are purportedly constituted by representations from particular perceptual modalities (e.g., motor control) that are more typically used in interacting with category members, semantic impairments should exhibit an interaction between semantic category and perceptual modality.

The semantic deficits arising from SD violate both of these predictions because they exhibit a "modality-general, item-specific" pattern (McCaffrey & Machery, 2012). Conceptual knowledge is lost in a hierarchical fashion (from specific to general) irrespective of category. Conceptual items from multiple categories (e.g., BEAR and BUCKET) can be impaired while other members of the same categories are intact. Additionally, the same pattern of highly cross-modal deficits—that is, deficits related to what a given item looks like, sounds like, feels like, etc.—is observed regardless of category. In other words, in SD there is no apparent interaction between conceptual category and perceptual modality for affected items as the modal domain hypothesis would predict.

4. Conceptual Vehicles Revisited

4.1. The Amodal Hub View

Bilateral degeneration of the ATLs leads to SD, a condition characterized by a progressive loss of conceptual knowledge in a modality general (i.e., highly cross-modal) and item-specific (i.e., related to particular category members rather than categories) fashion. But what does this pattern of deficits mean for how and where conceptual knowledge is organized in the brain? In this section, I discuss how research on SD and the ATLs bears on these issues. First, I discuss why some theorists take research on SD to imply that the ATLs are a central hub for amodal conceptual representations in the brain. Second, I examine the extent to which SD poses difficulties for two neo-empiricist claims: the modal domain hypothesis and the perceptual vehicles thesis. I argue that research on SD undermines the case for the modal domain hypothesis and by extension undercuts an important source of evidence for the perceptual vehicles thesis. After elaborating on this point, I examine whether SD supports amodal theories of conceptual vehicles.

The deficits observed in SD match many predictions of classical amodal theories of conceptual vehicles. A number of influential theories of semantic knowledge (e.g., Collins & Quillian, 1969) postulate that the mind contains a unitary, amodal store of conceptual information. On this view, various perceptual systems feed into a distinct system that stores information in the form of propositional elements (e.g., PENGUIN) that can be combined and recombined to form the propositions that underlie our conceptual competences (e.g., PENGUINS CAN'T FLY). Several theorists (Fodor, 1975; see also Barsalou, 1999 for a review) appeal to a unitary store of amodal representations to explain a diverse range of cognitive phenomena, including cross-modal transfer, categorical inferences, the productivity of thought, and the existence of abstract concepts. Amodal theories have traditionally predicted: 1) conceptual knowledge has a central hub; 2) feature information (e.g., BIRDS HAVE WINGS) and category information (e.g., ROBINS ARE BIRDS) are stored in a common place; and 3) representations in this central hub are couched in vehicles distinct from those found in perceptual systems.

Many authors (e.g., Coccia, Bartolini, Luzzi, Provinciali, & Ralph, 2004; Patterson et al., 2007) think that the pattern of semantic deficits in SD suggests that the ATLs constitute an amodal hub in the human conceptual system. On this view, distinct perceptual systems feed into the ATLs, which act as a store for concepts (e.g., ANIMAL) that are abstracted away from particular perceptual features. Numerous observations accord with this interpretation. First, SD causes deficits that are highly cross-modal (Bozeat et al., 2000). Second, the ATLs seem to possess other characteristics resembling those of a unitary, amodal conceptual store. For instance, lesions in the ATLs affect both feature information and category information (Garrard & Hodges, 2000; Patterson et al., 2007). In addition, studies using transcranial magnetic stimulation (TMS), a technique that transiently inactivates cortical regions in aware participants, suggest that the ATLs are involved in the comprehension of abstract concepts (Pobric, Lambon Ralph, & Jefferies, 2009) and provide further evidence that the ATLs are involved in semantic cognition across several conceptual categories (Pobric, Jefferies, & Lambon Ralph, 2010b).

Do the ATLs suggest a unitary, amodal hub for conceptual knowledge? Some theorists (e.g., Patterson et al., 2007) think that SD provides a compelling case for amodal representations. In what follows, I argue that this conclusion, while tempting, is too hasty (more on this in section 4.3). However, I think that research on SD and the role of the ATLs in conceptual processing is problematic for the modal domain hypothesis and the support it allegedly lends to the perceptual vehicles thesis.

4.2. The Modal Domain Hypothesis

The modal domain hypothesis predicts that conceptual knowledge is distributed throughout various modality-specific regions of the brain and that conceptual categories are structured and organized by perceptual representations. Several theorists (e.g., Kan et al., 2003; Kiefer & Pulvermüller, 2012) think that the existence of category-specific semantic deficits supports the modal domain hypothesis. In turn, evidence for the modal domain hypothesis is considered an important source of

support for the perceptual vehicles thesis in the following way: if conceptual information resides in perceptual regions and perceptual features play a role in structuring conceptual knowledge (i.e., in delineating semantic categories), then it is likely that conceptual knowledge consists of perceptual representations. However, as noted in section 3, the pattern of deficits observed in SD undermines support for the modal domain hypothesis. The modality-general, item-specific pattern of deficits in SD violates the modal domain hypothesis because: 1) there is no apparent interaction between category and modality for affected semantic items; and 2) damage to a single brain region causes semantic deficits that are highly multi-modal and cut across numerous conceptual categories.

There are several moves open to the proponent of the modal domain hypothesis. First, perhaps the existence of both category-specific semantic deficits (which often arise from lesions in perceptual areas of the brain) and category-general semantic deficits (which typically result from lesions in the ATLs) suggests that some conceptual knowledge is perceptual while some is not. Indeed, theorists who think that SD implies the existence of amodal representations in the ATLs often think that other aspects of conceptual knowledge do rely on perceptual representations—their favored model is called the "hub and spoke" model of semantic cognition (see, for example, Hoffman, Jones, & Lambon Ralph, 2012). On the hub and spoke model, conceptual knowledge consists partly of perceptual representations that encode feature knowledge and partly of amodal representations that reflect other kinds of knowledge. For instance, the concept CAR might consist of both perceptual images of the cars one has encountered (e.g., what cars look like) and amodal representations reflecting knowledge (e.g., knowing that cars and boats are both vehicles) that do not depend on perceptual representations of external features. While this is a viable option, there are two reasons to resist this move at this point in the discussion: 1) at this point, evidence for the modal domain hypothesis would cease to be evidence for the perceptual vehicles thesis (it would support a pluralistic theory of concepts instead); and 2) there are other ways to challenge my interpretation of deficits from SD.

One option explored by several theorists (e.g., Fadiga & Pulvermüller, 2010; Gainotti, 2012) is the idea that conceptual knowledge may be constituted by a number of distinct perceptual circuits. On this view, it is possible that conceptual knowledge is organized according to perceptual information and that the semantic deficits associated with SD result from damage to a number of distinct perceptual circuits involved in conceptual processing rather than the degradation of knowledge located within a unitary conceptual store. One reply to this objection is that while it is certainly possible that degeneration of the ATLs merely cuts across a number of distinct perceptual circuits that constitute conceptual knowledge, amodal theories predict that such an anatomical locus exists while it would be surprising on the modal domain hypothesis (after all, other lesions throughout the brain are unlikely to produce category-general semantic deficits). However, I don't think this is the most compelling reply because there may be reasons (e.g., the ability to draw analogies between different conceptual categories) why distinct perceptual circuits embodying diverse types of conceptual knowledge may need to anatomically converge.

A better reply to the objection that SD may cut across a number of distinct perceptual circuits embodying different aspects of conceptual knowledge is that this interpretation is inconsistent with longitudinal data on SD patients. If lesions to the ATLs disrupt several modality-specific circuits involved in semantic cognition, then as SD progresses, patients should exhibit category effects (i.e., more categories become affected as the disease progresses) or feature effects (i.e., more perceptual modalities become involved as the disease progresses). To elaborate, imagine that the ATLs are situated close to a number of perceptual circuits that encode various features of conceptual knowledge (e.g., motor loops that encode action verbs or circuits of the ventral visual stream that encode nouns for places). On the modal domain hypothesis, these circuits should be preferentially involved in representing particular semantic categories. On a slightly different view that is compatible with the perceptual vehicles thesis, perhaps these circuits are preferentially involved in representing certain modality-specific features of items across different categories (e.g., what cars, cows, and rivers *sound* like). These views predict that SD patients should experience progressive category effects or modality-specific feature effects as the disease progresses.

For instance, patients could first lose knowledge of living things, then knowledge of artifacts. Or patients could forget what a bird looks like, but retain their knowledge of bird song while simultaneously forgetting what a car looks like, but retain their knowledge of "vrooms." Unfortunately for this picture, numerous longitudinal studies of SD patients suggest the same pattern of cross-modal deficits for affected semantic items (Coccia et al., 2004; Lambon Ralph, Graham, Ellis, & Hodges, 1998)—even if some patients do experience category effects (for instance, Gainotti & Silveri, 1996 report that some SD patients are more impaired for some categories than others), these category effects are not correlated with modality-specific deficits in the way the modal domain hypothesis predicts. However, it is worth noting that the longitudinal data is not univocal in its support for modality-general semantic deficits. Gainotti (2012), for example, reports that data on early SD patients (who often have disproportionate lesions in one hemisphere) suggests that the left ATL is involved in verbal knowledge while the right ATL is involved in pictorial knowledge. I raise two considerations in reply. First, other studies (e.g., Pobric, Jefferies, & Lambon Ralph, 2010a) fail to support this picture.[5] Second, if conceptual knowledge is organized according to perceptual modalities, but in a way that does not link perceptual modalities to specific conceptual categories, this calls for a revision of the modal domain hypothesis. At best, longitudinal data on SD patients calls for a substantial revision of the modal domain hypothesis. At worst, the modal domain hypothesis simply fails to account for extant longitudinal data.

A second option explored by neo-empiricists (e.g., Kiefer & Pulvermüller, 2012; Prinz, 2010) is that so-called "amodal" regions of the brain, such as the ATLs, may be causally involved in deploying conceptual knowledge, but that the representations that actually constitute that knowledge are nevertheless distributed throughout perceptual regions of the brain. Following Weiskopf (2007), I call this the "mechanisms strategy." Proponents of the mechanisms strategy might claim that the ATLs act as a kind of

switchboard for conceptual knowledge. For instance, when someone asks "does a dog have a tail?" the ATLs might be involved in searching the brain for the right representation (e.g., a perceptual simulation of a dog) to answer the question. On this view, it is entirely possible that the representation that the ATLs help bring online resides in some perceptual region of the brain. Consistent with this interpretation is the fact that lesions in perceptual regions sometimes cause category-specific semantic deficits (Kan et al., 2003) while lesions in the ATLs result in category-general semantic deficits (Patterson et al., 2007). Similarly, Pobric et al. (2010a) report that applying TMS to the intraparietal lobule, a region implicated in sensorimotor integration, causes semantic deficits that are specific to artifacts.

Weiskopf (2007) argues that the mechanisms strategy fails because neo-empiricists do not have a principled distinction on hand between neural activity that represents and neural activity that brings representations online "mechanically." I am sympathetic to this concern, but think that even if such a distinction exists, the ATLs are likely to play a representational role in at least certain kinds of conceptual processing. Specifically, the ATLs seem to play an important role in comprehending abstract concepts and judging category membership (Mayberry, Sage, & Lambon Ralph, 2011; Pobric et al., 2009).

Mayberry et al. (2011) hypothesized that two kinds of category judgments, those involving pseudotypical exemplars and atypical exemplars, might require access to representations that go against the grain of perceptual similarity. An example of an atypical exemplar is a sea sponge—it does not look like an animal, but it is. An example of a pseudotypical exemplar is a dolphin—it looks like a fish, but it is not. Mayberry et al. (2011), who hypothesized that the ATLs make an amodal contribution to category formation, found that patients with more severe SD were prone to both overgeneralization errors (e.g., a dolphin is a fish) and undergeneralization errors (e.g., a sea sponge is not an animal). The effect was robust across different modalities (e.g., picture sorting and naming tasks) and different conceptual categories (e.g., animals, fruits, tools, etc.), suggesting that the ATLs play a role in making category judgments that override perceptual similarity. Likewise, Pobric et al. (2009) found that inactivating the ATLs using TMS caused disproportionate deficits in the comprehension of abstract compared to concrete words.

I take these results to suggest that the ATLs play a role in representing certain kinds of concepts (i.e., abstract ones) and in making certain kinds of category judgments (i.e., judgments that go against the grain of typicality). Of course, the neo-empiricist might insist that while the ATLs are involved in these semantic capacities, the representations that underlie these capacities are nonetheless distributed over various perceptual regions. To be sure, SD only provides evidence that lesions in the ATLs impair certain semantic capacities (e.g., abstract concept comprehension); it does not provide evidence against the claim that some other system actually contains the representations underlying those capacities. But this seems to set up an unfair playing field in which the perceptual vehicles thesis can accommodate any finding that seems to contradict it—after all, it is far easier to claim that the relevant representations reside elsewhere than to produce neuropsychological results that bear

on conceptual vehicles. Confronted with research on SD, the burden is on the neo-empiricist to explain, for example, why lesions to the ATLs result in greater impairments to abstract than concrete concepts. More empirical data is needed to resolve these issues. For instance, it would be interesting to know whether lesions (or TMS) of perceptual regions would also affect the semantic capacities (e.g., abstract concept comprehension and category judgments that defy perceptual similarity) in which the ATLs are implicated.

4.3. The Perceptual Vehicles Thesis

I claim that research on SD undermines the modal domain hypothesis. The modality-general, item-specific pattern of deficits in SD conflicts with the predictions that conceptual knowledge is distributed throughout the brain's perceptual regions and that conceptual categories are structured by specific perceptual modalities. Since neo-empiricists frequently invoke evidence that conceptual knowledge is distributed throughout perceptual regions of the brain to support the perceptual vehicles thesis (see, for example, Barsalou, 2008), these considerations undermine an important strand of support for perceptual vehicles. Even worse, the ATLs have several features reminiscent of classical amodal stores. This raises the question: does research on SD support an amodal account of conceptual vehicles? In this section, I argue that while research on SD and the ATLs poses problems for the neo-empiricist, it does not count as evidence against the perceptual vehicles thesis per se. Along the way, I highlight some unresolved theoretical and empirical issues for the study of conceptual vehicles.

Prinz (2002) claims that a representation is perceptual if: 1) it is found in a perceptual region or 2) it shares the representational format (i.e., vehicular properties) of representations found in perceptual regions. The perceptual vehicles thesis proposes that all conceptual knowledge satisfies at least one of these two conditions. By contrast, amodal theorists (e.g., Collins & Quillian, 1969) think that conceptual knowledge is couched in representations that are distinct from those used in sensory, motor, and affective systems. While research on the ATLs seems to fit well with the notion of a unitary, amodal store, there are two reasons for resisting this conclusion: first, localization data does not speak directly for or against the perceptual vehicles thesis; and second, it is unclear how interpretations of SD generalize to conceptual knowledge as a whole.

First, note that the perceptual vehicles thesis is foremost a claim about the format or nature of conceptual knowledge—it essentially concerns whether or not concepts represent their content *in a particular way* (i.e., perceptually). But both amodal theorists (e.g., Patterson et al., 2007) and neo-empiricists (e.g., Kan et al., 2003) appeal to information about *what* systems (e.g., perceptual or association brain areas) implement conceptual knowledge or *where* (i.e., whether knowledge is centralized or distributed) conceptual knowledge resides (i.e., localization data) in order to support their theories of conceptual vehicles. Since the perceptual vehicles thesis is mainly a thesis about *how* concepts represent, rather than *what* does the representing or *where* the representing occurs, it seems that localization evidence can at best count as

indirect evidence for or against particular theories of conceptual vehicles. As an example of how this affects the dialectic, Kiefer and Pulvermüller (2012) point out that the issue of whether conceptual processing is central or distributed is distinct from the issue of whether conceptual processing is modality-specific or amodal.

While amodal theorists have typically endorsed centralized processing and neo-empiricist theories have typically endorsed distributed processing, the opposite might be the case: perhaps conceptual knowledge is couched in a central, modal system or a distributed amodal one. Indeed, neo-empiricists (e.g., Prinz, 2002) frequently claim that concepts are rich, multi-modal representations. If this view of conceptual vehicles is correct, why think that conceptual knowledge must be distributed in particular perceptual systems? Theorists who endorse the idea that the ATLs house amodal conceptual representations appeal to two sorts of findings: 1) SD results in highly multi-modal deficits; and 2) these deficits occur across numerous conceptual categories. But since it remains unclear what the ATLs do (i.e., how they operate on information received from various perceptual regions), it is possible that they are involved in generating or accessing multi-modal perceptual representations. For instance, Patterson et al. (2007) think that because SD causes highly multi-modal deficits, the ATLs implement amodal representations while Bonner, Peelle, Cook, and Grossman (2013) interpret the same data as suggesting that the anterior temporal lobes house "heteromodal" perceptual representations (i.e., representations that are encoded in several different perceptual formats). These disputes suggest that theories about how integrative regions such as the ATLs contribute to conceptual knowledge are needed; localization data alone is insufficient to advance debates about conceptual vehicles.

Second, it is unclear how research on SD generalizes to other conceptual domains or concepts as a whole. While the ventral stream and the ATLs seem important for processing noun information, a number of studies (e.g., Miller, Nieder, Freedman, & Wallis, 2003; Pulvermüller, Härle, & Hummel, 2000) suggest that other aspects of conceptual knowledge are implemented in different neural circuits. For example, Miller et al. (2003) report that parietal and frontal circuits are particularly important for number cognition. Interestingly, Pobric et al. (2010a) also report that TMS of the ATLs in healthy patients produces deficits in noun, but not number naming tasks. However theorists interpret the role of the ATLs in conceptual processing (i.e., whether it contributes to perceptual or amodal representation), neuroimaging studies and neuropsychological data suggest that the ATLs do not participate in all forms of conceptual knowledge.

Several theorists have come to think that a compromise is needed between purely amodal and purely perceptual theories of conceptual vehicles. Dove (2011) proposes a pluralistic theory in which some concepts (e.g., concrete nouns) are embodied while others (e.g., abstract concepts) are amodal or "disembodied." This raises the possibility that concepts within certain domains are grounded in perceptual representations while other kinds of concepts are not. Malt (2010) endorses a hybrid theory in which concepts are partly constituted of perceptual representations (e.g., images) and partly constituted of amodal (e.g., relational or thematic) representations. Both of these views are consistent with extant data on conceptual vehicles. For instance, there is no

guarantee that mathematical concepts and concrete noun concepts, which seem to have separate neural substrates (Miller et al., 2003), are couched in the same conceptual vehicles. Likewise, given the fact that lesions in some perceptual regions result in uni-modal, category-specific semantic deficits (Kan et al., 2003) and lesions in the ATLs result in multi-modal, category-general semantic deficits, it is possible that different facets of the same concept (e.g., what an animal looks like versus whether or not it is a mammal) are stored in different representational formats. While the ATLs behave like an amodal conceptual hub in several ways, this does not mean that all conceptual knowledge is couched in a common, amodal format.

5. Lessons from Semantic Dementia

In this essay, I have argued that the pattern of deficits in SD undermines the modal domain hypothesis, which states that conceptual knowledge is stored throughout perceptual regions of the brain and that conceptual categories are structured by specific perceptual modalities (e.g., vision or touch) that are most commonly used to interact with category members. I discussed a number of ways in which the ATLs, the brain region implicated in SD, behave like a unitary, amodal conceptual store. Contrary to what a number of neo-empiricists (e.g., Barsalou, 2008; Kan et al., 2003) think, neuropsychology does not unequivocally support the perceptual vehicles thesis. However, I deny that research on SD supports the view that all conceptual knowledge is couched in a single, amodal format. I conclude by discussing a couple lessons for future theorizing about conceptual vehicles.

First, my analysis of neuropsychology and conceptual vehicles reinforces Machery's (2007) worry that both amodal theories and neo-empiricists face "Anderson's problem"—that is, both types of theories can accommodate a wide range of empirical data and, in many cases, generate the same empirical predictions. For example, Prinz (2002) thinks that abstract concepts such as TRUTH or DEMOCRACY are complex, highly multi-modal representations (they consist of things such action simulations, representations of pictures and symbols, etc.). This theory would predict that the concept TRUTH is implemented in a highly multi-modal area of the brain, such as higher-order association cortex, that draws together different streams of perceptual information. By contrast, amodal theories propose that abstract concepts such as TRUTH reside in a conceptual system separate from particular perceptual systems; of course, this theory would also predict that the concept TRUTH is stored in a part of the brain, such as higher-level association cortex, that draws together different streams of perceptual information.

It is therefore unlikely that particular empirical findings will be able to validate or refute particular theories of conceptual vehicles. Instead, the details of these theories need to be spelled out in ways that generate specific empirical predictions. For example, the modal domain hypothesis, which claims that conceptual knowledge (e.g., categorization schemes) is distributed throughout various perceptual regions of the brain, is a particular interpretation of the perceptual vehicles thesis that accords with the existence of category-specific semantic deficits. However, the modal domain

hypothesis fails to account for the existence of domain-general, category general semantic deficits. When theorists reach an impasse like the one I described above (i.e., that association areas of the brain can be conceived as amodal or highly multi-modal), theories generating novel predictions will be needed to adjudicate between competing views. The upshot is that it is unlikely there will be a single, decisive battle in the conflict between amodal theories and neo-empiricism; instead, different empirical domains will likely provide a patchwork of local disputes.

Second, my discussion suggests that richer versions of both amodal theories and neo-empiricist theories are probably needed to account for the diverse range of empirical findings from neuropsychology. Alternatively, extant data from cognitive neuroscience and neuropsychology is also consistent with hybrid and pluralistic theories of conceptual vehicles. In evaluating these alternatives, it is important to bear in mind that localization data (i.e., data about where conceptual knowledge is implemented or data about what structures are involved in semantic cognition) only speaks indirectly for or against particular theories of conceptual vehicles. Neuropsychology is a rich source of evidence about where and how conceptual knowledge is organized, but to take advantage of it properly, researchers will need to develop theories that predict the diverse patterns of semantic deficits that arise from neuropathology in different regions of the brain. For example, it would be useful to know why damage to perceptual regions causes category-specific semantic deficits while damage to an apparent hub region causes category-general semantic deficits. Additionally, it is unclear why SD impairs certain kinds of conceptual knowledge, such as facts about people, tools, and living things, and spares knowledge from other domains, such as numerical cognition. Even if research on SD raises more questions than answers, addressing these puzzles will enrich debates in philosophy and psychology about the nature of conceptual vehicles.

Acknowledgements

Many thanks to Edouard Machery, William Bechtel, Daniel Burnston, Michael Anderson, Sharon Thompson-Schill, John Michael, Trey Boone, and two anonymous reviewers for the 38th Annual Meeting of the Society for Philosophy and Psychology for helpful advice and comments on earlier versions of the paper.

Notes

[1] Several theorists (e.g., Barsalou, 2008) argue that concepts can be grounded in numerous kinds of perceptual systems including sensory, motor, affective, and other introspective (e.g., proprioceptive) systems. Throughout this paper, I will use 'perceptual' in this capacious sense to refer to the suite of modality-specific representations taken by some to underlie conceptual knowledge.

[2] Weiskopf (2007) notes that not all concept empiricists endorse the strong, global form of the perceptual vehicles thesis. For instance, pluarlistic theories (e.g., Dove, 2011) propose that only some concepts are perceptual while others are amodal or "disembodied." On the other hand, hybrid theories (e.g., Malt, 2010) propose that all concepts consist partly of perceptual representations and partly of different kinds of representation.

[3] Space considerations prevent me from presenting these arguments in detail. For a discussion of whether cognitive psychology supports neo-empiricism (and whether it can adjudicate between different theories of conceptual vehicles), see Machery (2007).

[4] However, there is room for debate about whether the ATLs should be thought of as a single brain region. Gainotti (2012), for example, argues that the left and right temporal lobes are specialized for different aspects (verbal and pictorial, respectively) of conceptual knowledge.

[5] Pobric et al. (2010a) found that TMS applied to the left anterior temporal lobe or right anterior temporal lobe caused similar deficits in semantic processing of both words and pictures.

References

Bak, T. H., O'Donovan, D. G., Xuereb, J. H., Spillantini, M. G., Boniface, S., & Hodges, J. R. (2001). Selective impairment of verb processing associated with pathological changes in Brodmann areas 44 and 45 in the motor neurone disease-dementia-aphasia syndrome. *Brain*, *124*, 103–120.

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.

Bonner, M. F., Peelle, J. E., Cook, P. A., & Grossman, M. (2013). Heteromodal processing in the angular gyrus. *Neuroimage*, *71*, 175–186.

Borghi, A. M., Glenberg, A. M., & Kashak, M. P. (2004). Putting words into perspective. *Memory and Cognition*, *32*, 863–873.

Bozeat, S., Lambon Ralph, M., Patterson, K., Garrard, P., & Hodges, J. (2000). Non-Verbal semantic impairment in semantic dementia. *Neuropsychologia*, *38*, 1207–1215.

Caramazza, A., & Mahon, B. Z. (2003). The organization of conceptual knowledge: The evidence from category-specific semantic deficits. *Trends in Cognitive Sciences*, 7, 354–361.

Coccia, M., Bartolini, M., Luzzi, S., Provinciali, L., & Ralph, M. A. (2004). Semantic memory is an amodal dynamic system: Evidence from the interaction of naming and object use in semantic dementia. *Cognitive Neuropsychology*, *21*, 513–527.

Collins, A., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, *8*, 240–247.

Crane, T. (2003). *The mechanical mind: A philosophical introduction to minds, machines, and mental representation* (2nd ed.). New York: Routledge.

Cree, G. S., & McRae, K. (2003). Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). *Journal of Experimental Psychology: General*, *132*, 163–201.

Dilkina, K., McClelland, J. L., & Plaut, D. C. (2008). A single system account of semantic and lexical deficits in five semantic dementia patients. *Cognitive Neuropsychology*, *25*, 136–164.

Dove, G. (2011). On the need for embodied and disembodied cognition. *Frontiers in Psychology*, *1*, 1–13.

Fadiga, L., & Pulvermüller, F. (2010). Active perception: Sensorimotor circuits as a cortical basis for language. *Nature Reviews Neuroscience*, *11*, 351–359.

Fodor, J. A. (1975). *The language of thought*. Cambridge, MA: Harvard University Press.

Gainotti, G. (2012). The format of conceptual representations disrupted in semantic dementia: A position paper. *Cortex*, *48*, 521–529.

Gainotti, G., & Silveri, M. C. (1996). Cognitive and anatomical locus of lesion in a patient with a category-specific impairment for living beings. *Cognitive Neuropsychology*, *13*, 357–389.

Gallese, V., & Lakoff, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive Neuropsychology*, *22*, 455–479.

Garrard, P., & Carrol, E. (2006). Lost in semantic space: A multi-modal, non-verbal assessment of feature knowledge in semantic dementia. *Brain*, *129*, 1152–1163.

Garrard, P., & Hodges, J. R. (2000). Semantic dementia: Clinical, radiological and pathological perspectives. *Journal of Neurology*, *247*, 409–422.

Hoffman, P., Jones, R. W., & Lambon Ralph, M. A. (2012). The degraded concept representation system in semantic dementia: Damage to pan-modal hub, then visual spoke. *Brain*, *135*, 3770–3780.

Kan, I. P., Barsalou, L. W., Solomon, K. O., Minor, J. K., & Thompson-Schill, S. L. (2003). Role of mental imagery in a property verification task: fMRI evidence for perceptual representations of conceptual knowledge. *Cognitive Neuropsychology*, *20*, 525–540.

Kiefer, M., & Pulvermüller, F. (2012). Conceptual representations in the mind and brain: Theoretical developments, current evidence, and future directions. *Cortex*, *48*, 805–825.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to Western thought*. New York: Basic.

Lambon Ralph, M. A., Graham, K. S., Ellis, A. W., & Hodges, J. R. (1998). Naming in semantic dementia—What matters? *Neuropsychologia*, *36*, 775–784.

Machery, E. (2007). Concept empiricism: A methodological critique. *Cognition*, *104*, 19–46.

Mahon, B. Z., & 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.

Malt, B. (2010). Why we should do without concepts. *Mind and Language*, *25*, 622–633.

Martin, A., Wiggs, C. L., Ungerleider, L. G., & Haxby, J. V. (1996). Neural correlates of category-specific knowledge. *Nature*, *379*, 649–652.

Mayberry, E., Sage, K., & Lambon Ralph, M. (2011). At the edge of semantic space: The breakdown of coherent concepts in semantic dementia is constrained by typicality and severity but not modality. *Journal of Cognitive Neuroscience*, *23*, 2240–2251.

McCaffrey, J., & Machery, E. (2012). Philosophical issues about concepts. *Wiley Interdisciplinary Reviews: Cognitive Science*, *3*, 265–279.

Miller, E., Nieder, A., Freedman, D., & Wallis, J. (2003). Neural correlates of categories and concepts. *Current Opinion in Neurobiology*, *13*, 198–203.

Millikan, R. G. (1993). Content and vehicle. In N. Eilan, R. A. McCarthy, & B. Brewer (Eds.), *Spatial representation: Problems in philosophy and psychology* (pp. 256–268). Oxford: Blackwell.

Patterson, K., Nestor, P. J., & Rogers, T. T. (2007). Where do you know what you know? The representation of semantic knowledge in the human brain. *Nature Reviews Neuroscience*, *8*, 976–987.

Pobric, G., Jefferies, E., & Lambon Ralph, M. A. (2010a). Amodal semantic representations depend on both anterior temporal lobes: Evidence from repetitive transcranial magnetic stimulation. *Neuropsychologia*, *48*, 1336–1342.

Pobric, G., Jefferies, E., & Lambon Ralph, M. A. (2010b). Category-Specific versus category-general semantic impairment induced by transcranial magnetic stimulation. *Current Biology*, *20*, 964–968.

Pobric, G., Lambon Ralph, M. A., & Jefferies, E. (2009). The role of the anterior temporal lobes in the comprehension of abstract and concrete words: rTMS evidence. *Cortex*, *45*, 1104–1110.

Prinz, J. J. (2002). *Furnishing the mind: Concepts and their perceptual basis*. Cambridge, MA: MIT Press.

Prinz, J. J. (2005). The return of concept empiricism. In H. Cohen & C. Lefebvre (Eds.), *Handbook of categorization in cognitive science* (pp. 679–695). Amsterdam: Elsevier.

Prinz, J. J. (2010). Can concept empiricism forestall eliminativism? *Mind & Language*, *25*, 612–621.

Pulvermüller, F., Härle, M., & Hummel, F. (2000). Neurophysiological distinction of verb categories. *Neuroreport*, *11*, 2789–2793.

Rosch, E. (1975). Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, *104*, 192–233.

Rugg, M. D., & Thompson-Schill, S. L. (2013). Moving forward with fMRI data. *Perspectives on Psychological Science*, *8*, 84–87.

Shallice, T. (1988). *From neuropsychology to mental structure*. Cambridge: Cambridge University Press.

Snowden, J. S., Goulding, P. J., & Neary, D. (1989). Semantic dementia: A form of circumscribed cerebral atrophy. *Behavioral Neurology*, *2*, 167–182.

Warrington, E. K., & Shallice, T. (1984). Category specific semantic impairments. *Brain*, *107*, 829–853.

Weiskopf, D. (2007). Concept empiricism and the vehicles of thought. *Journal of Consciousness Studies*, *14*, 156–183.

Yeo, R. A., Turkheimer, E., & Bigler, E. D. (1990). Neuropsychological methods of localizing brain dysfunction: Clinical versus empirical approaches. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *3*, 290–303.