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Classification Systems Offer A Microcosm of Issues in Conceptual Processing: A Commentary on Kemmerer (2016)

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Abstract

This is a commentary on Kemmerer (2016), Categories of Object Concepts Across Languages and Brains: The Relevance of Nominal Classification Systems to Cognitive Neuroscience, DOI: 10.1080/23273798.2016.1198819.

1. Introduction

Kemmerer (2016) first reviews nominal classification systems, in which classifiers (linguistic elements that accompany nouns) highlight featural information in noun meanings, including animacy, shape, size, constitution, and interaction. Kemmerer then reviews neuroscience research showing that the brain represents these features, often in exquisite detail. Specifically, neuroscience research has established neural systems in the brain that distinguish specific forms of features for:

(1) animacy (e.g., species, social status, rationality),

(2) shape (e.g., geometric solids, non-accidental properties),

(3) size (e.g., function, gender, deviation from average size),

(4) constitution (e.g., material independent of shape),

(5) interaction/function (e.g., actions, outcomes).

Importantly, however, this neuroscience research has not yet used classifiers to establish the neural bases of these features, but has primarily used other linguistic stimuli together with pictures. Thus, no actual relations have yet been established between the features that classifiers represent and the neural representations of these features.

Kemmerer's important insight and message is that classification systems, not only offer a powerful tool for exploring conceptual processing in the brain, but must be addressed to fully understand how the brain implements conceptual processing. Because classification systems are central in many language communities, we cannot understand how the brain realizes conceptual processing without establishing their roles and long-term effects. Furthermore, because the presence of a classification system in an individual's language environment changes how their brain implements conceptual processing behaviorally, the potential effects on the underlying neural systems must be explored as well (in the spirit of the Linguistic Relativity Hypothesis; e.g., Enfield, 2015; Everett, 2013).

In this commentary, I propose that the issues associated with understanding the neural bases of classification systems constitute a microcosm of current issues associated with understanding the neural bases of conceptual processing more generally, including: (1) the genetic vs. experiential origins of conceptual features, (2) the roles of grounding and abstraction in representing features, (3) the roles of basic cognitive mechanisms in conceptual processing, including attention, frequency, and context-dependent meaning construction, (4) the roles of concepts in situated cognition and action. The following sections address each issue in turn.

2. Origins of Conceptual Features

On the one hand, the exquisite sensitivity that the brain shows to fine distinctions in conceptual features is impressive. On the other, this sensitivity is perhaps not so surprising, given that any discriminable difference in conceptual information must have a neural basis. If people are confronted with two different features and can tell them apart, different neural representations must be responsible.

2.1. Genetic vs. experiential origins. A key and classic issue concerns how much the distinctions that underlie classifiers reflect genetic vs. experiential contributions. The fact that some classifiers occur across languages suggests that they reflect genetic origins. Conversely, the complementary fact that some classifiers are unique to a specific language suggests that they originate in the experience of the respective language community.

In principle, even common classifiers could originate purely in experience, simply indicating that the respective categories in the environment are common across language cultures, such that acquired conceptual knowledge is forced to distinguish them. Perhaps the most likely possibility is that neural systems have evolved to anticipate the kinds of featural distinctions found in typical human environments, but that experience is required to establish the ultimate representations that implement them. In other words, genetic constraints exist on these features, but environmental experience is necessary for constructing the specific neural structures that represent them in the brain (e.g., Elman et al., 1996; Malt, 1995). Kemmerer's (2016) observation that non-human species sometimes distinguish these features might indeed suggest a strong genetic contribution. Again, however, a shared environment across species could play significant roles in establishing these features.

2.2. Developmental pruning. Regardless of the difficulty in establishing the origins of the features that underlie classifiers, an important issue to bear in mind concerns how children acquire them during language acquisition. An intriguing possibility is that these features develop similar to how phoneme and face categories develop (e.g., Maurer & Werker, 2014; Werker & Hensch, 2015).

Initially, evolutionary-based neural architecture anticipates the space of possible features that could be encountered for all possible classifiers and their associated referents, with the experience of specific features then pruning and entrenching the features that remain. If so, then classification systems may be a way of selecting and entrenching features that a language community anticipates will be important for its members.

3. Roles of Grounding and Abstraction

Because neuroscience research has not yet addressed the neural bases of classifiers, we have no idea of whether or not they utilize the neural systems that Kemmerer (2016) reviews. Certainly, they may, but alternatives for representing the featural information associated with classifiers must be considered as well. Current research on conceptual processing suggests diverse ways in which the semantic content of classifiers could be represented. Following Barsalou (2016), such content could potentially be represented via various mechanisms associated with grounding and abstraction. These possibilities are addressed in turn.

3.1. Grounding. An obvious possibility is that the semantic content of a classifier could be represented by the brain areas that process the relevant features of its referents during perception and action (e.g., Barsalou, 1999, 2008, Martin, 2007, 2015). In other words, the brain areas that Kemmerer (2016) reviews, not only support the processing of these features during perception and action, they also represent (ground) the meanings of classifiers that refer to these features. As a consequence, hearing or reading a classifier reactivates or simulates the respective feature areas, thereby adding (or strengthening) them in the representation of the classified noun.

3.2. Abstraction. Barsalou (2016) reviews several types of abstraction that could potentially also represent classifier semantics. One possibility is that a compressed representation of a classifier's features (such as a prototype) is stored in association areas and grounded in the corresponding features of the relevant sensory-motor systems (e.g., Binder, 2016; Fernandino et al., 2015). These compressed abstractions could potentially represent a classifier's semantics without sensory-motor grounding becoming active, such that the areas Kemmerer (2016) reviews play little or no role when classifiers are processed. Alternatively, both the abstract and grounded representations could become active together to represent a classifier's semantics as a coordinated distributed network.

Another possibility is that distributed linguistic representations play a central role in classifier semantics (e.g., Baroni & Lenci, 2010; Erk, 2012; Landauer, McNamara, Dennis, & Kintsch, 2013). Given the conventional linguistic nature of classifiers, it makes sense that they would capitalize on this form of abstraction. Specifically, a classifier could be associated with all (or many of) the word forms for the nouns it classifies, such that these word forms represent the classifier's meaning in a distributed manner. When the classifier is heard or read, it activates these word forms (or a subset), which contribute to the classifier's meaning. Because one of these word forms is likely to be the noun currently classified, the classifier primes it, speeding up linguistic processing.

A final possibility is that classifiers are represented with amodal symbols arbitrarily related to their meaning. Although it's not clear where in the brain amodal symbols are stored (if anywhere) or how they work (Barsalou, 2016), it is probably important to entertain the possibility that classifiers, like any other concepts, could potentially be represented in some way that has nothing to do with grounding or linguistic forms.

In summary, a potential issue for research on classifiers is to establish how grounding and abstraction implement classifier semantics. A likely possibility, consistent with how other concepts are represented, is that multiple representations work together, including grounding, compressed abstractions, and distributed linguistic representations (e.g., Andrews, Frank, & Vigliocco, 2014; Barsalou, Santos, Simmons, & Wilson, 2008; Connell & Lynott, 2013; Louwerse, 2011; Paivio, 1986).

4. Roles of Basic Cognitive Mechanisms

A variety of additional cognitive mechanisms potentially influence classifier semantics, including attention, frequency, superordinate categories, concept composition, and context-dependent meaning construction. Each is addressed in turn.

4.1. Attention. A likely possibility, consistent with Kemmerer's (2016) review, is that a classifier draws attention to relevant features in a noun's meaning, thereby increasing their salience and activation. As much neuroscience research shows, focusing selective attention on a feature increases neural activity in brain regions that process it (e.g., Corbetta, Miezin, Dobmeyer, Shulman,

& Petersen, 1991; Schoenfeld et al., 2007). Consistent with grounded approaches, a classifier activates relevant sensory-motor regions that represent its underlying features by causing selective attention to focus on them. To the extent that attention plays this role, it becomes essential to consider attentional processes when attempting to understand how classifiers contribute to the representation of noun meaning. Consistent with many traditional approaches to conceptual processing (e.g., Kruschke, 1992; Nosofsky, 2011; Trabasso & Bower, 1975), attention highlights featural information relevant for a concept, with classifiers constituting one means of doing so.

4.2. Frequency. A closely related possibility is that repeatedly focusing attention on a feature strengthens its representation in memory, causing it to become entrenched and increasingly available for processing. Indeed, many theories have argued that attention and frequency work together to establish representations in memory (e.g., Barsalou, 1999; Craik, 2002; Craik & Lockhart, 1972; Trabasso & Bower, 1975). Where attention goes, memory follows.

To the extent that a classifier focuses attention on the neural representation of a feature frequently, the population of neurons processing the feature is likely to grow, as is the strength of its connections to related processing areas. As a result, an entrenched distributed network develops to represent the classifier's meaning. To the extent that such a process underlies classifier use, it is important to examine the early acquisition and development of these networks. Because the networks that represent classifiers are also likely to become associated with their associated nouns, these additional pathways are also important to examine. As a classifier is learned, a well-established entrenched network should develop for it and the nouns it classifies.

One important issue to consider is whether classifiers simply produce frequency increments on conceptual representations, or whether they produce additional effects as well. Perhaps the only effect of using a classifier frequently with a noun is to increase the overall salience of the classifier's features in the noun's representation via the repeated focusing of attention on them. If classifiers have additional effects on semantic content, it is important to specify what they are, and to develop empirical methods for establishing them.

4.3. Superordinate categories. As Kemmerer (2016) notes, classifiers can be viewed as superordinate categories that classify their associated nouns as basic or subordinate categories. When a classifier indicates that a noun is animate, for example, the animate classifier functions as a superordinate category for animate entities.

If classifiers function as superordinate categories, several issues arise. First, would performing a superordinate classification in a non-classifier language be the same as using the corresponding classifier in a classifier language? If, for example, someone says, "I just bought yet another inanimate object, a car, yesterday" is this equivalent to replacing "inanimate object" with the appropriate classifier (and classifier syntax) in a classifier language? If so, then this suggests that non-classifier languages have the same linguistic tools as classifier languages, but don't require that these tools always be used when referring to a noun. When they are used, however, they have essentially the same impact as a classifier, drawing attention to the relevant features and strengthening their representations in memory.

A robust finding in the behavioral concepts literature suggests that superordinate categories often become implicitly active for basic and subordinate categories, even when a superordinate category is not mentioned explicitly. Barsalou and Ross (1986), for example, showed that when people process basic categories (e.g., apple, hammer, shirt), their respective superordinate categories become active implicitly (i.e., fruit, tool, clothing). Similarly, many experiments show that when people list the features of concepts, they produce superordinates frequently, indicating that they are readily available (e.g., McRae, Cree, Seidenberg, & McNorgan, 2005; also see Barsalou & Wiemer-Hastings, 2005; Santos, Chaigneau, Simmons, & Barsalou, 2011; Wu & Barsalou, 2009).

Such findings suggest that important superordinates become active for concepts even in non-classifier languages. If so, then one potentially important issue is whether the activation of superordinate representations is roughly equivalent to the use of classifiers. Perhaps one important difference is that classifiers draw attention to features that typical superordinates don't usually capture, perhaps because it's important to make these additional features available for cultural interactions. This possibility is explored later.

4.4. Noun phrase composition. Languages generally include a wide variety of syntactic tools for modifying nouns, including adjective modifiers, noun modifiers, and phrase modifiers (e.g., prepositional phrases, relative clauses). Thus, an important question is whether classifiers offer a unique mechanism for modifying nouns, or whether they are similar in character to other syntactic tools for modifying nouns. Does a classifier have essentially the same effects as an adjective or noun modifier accompanying a noun? For example, does the adjective modifier in "large car" produce the same effect as combining a classifier for large with car? Similarly, does the noun modifier in "wood spoon" produce the same effect as combining a classifier for wooden composition with spoon? If so, then the primary function of classifiers, similar to noun modifiers and superordinates, may be to focus attention on relevant features, increasing their salience and entrenchment in concepts. Again, however, classifiers may play additional important roles.

Perhaps one way to frame the issue is as follows: If two non-classifier languages have different distributions of adjective and noun modifiers for animacy, shape, size, composition, and interaction, are the effects on the respective conceptual systems comparable to having two different classifier systems that highlight analogous featural differences? A similar issue exists for different distributions of superordinates in two language communities.

4.5. Context-dependent meaning construction. Increasing research demonstrates that a given concept is represented in infinitely many ways, taking different forms in different contexts to serve current goal-directed activity (e.g., Barsalou, 2016; Casasanto & Lupyan, 2015; Connell & Lynott, 2014; Kemmerer, 2015; Lebois, Wilson-Mendenhall, & Barsalou, 2015; Yee & Thompson-Schill, 2016). Classifiers similarly appear to implement context-dependence in at least two ways.

First, classifiers implement context-dependence with respect to different language communities. If one community uses a classifier that highlights a feature but another community doesn't, then the classifier may cause the feature to be more salient in the first community than in the second. Across language communities, different classifier systems for a given conceptual domain (e.g., animals) could cause the domain to be represented differently, as a function of how classifiers differentially draw attention to features and entrench them in memory.

Second, once an entrenched conceptual system is in place for a given language community, classifiers offer one (of many) mechanisms for producing context-dependent representations. As Kemmerer (2016) notes, some languages allow different classifiers to be used with the same noun, depending on which features are relevant in the current context. As different features become relevant across contexts, different classifiers are used to highlight them, thereby contributing to context-dependent representations.

Thus, another potential issue to explore in establishing the neural bases of classifiers is how they contribute to differences in meaning, first, across language communities, and second, across communicative contexts. Indeed, such issues lie at the heart of Kemmerer's (2016) proposal that the conceptual system cannot be fully understood without understanding the role of classifiers. Because classifiers have the potential to alter the structure of a conceptual system and its use, we cannot understand conceptual systems without taking classifiers into account. The additional point here is that classifier systems could potentially be viewed as belonging to a larger family of mechanisms that cause conceptual representations to be context-dependent.

5. Roles in Situated Cognition and Action

Perhaps classifiers are meaningless conventions whose original historical uses have become opaque. Although classifiers highlight features in an object's representation, this highlighting process may no longer play any important cultural functions. Instead, it is simply a remnant of functions that have long been forgotten.

Alternatively, classifiers could serve to consistently make features salient that are important for how a language community organizes social interaction and object use. By consistently activating these features, classifiers establish stable conceptual representations in memory that support the community's goals. Perhaps linguistic communities continue to use classifiers because the conceptual stability that they produce remains useful.

Kemmerer (2016) doesn't explore the roles that classifiers potentially play situated cognition and action. If classifiers are simply conventions, there is probably no need to explore such roles further. If, however, classifiers continue to help coordinate social cognition and action, then exploring these roles is likely to be important in fully understanding them. Many of the features that classifiers highlight could potentially serve such purposes. Animacy classifiers, for example, could prime features for status, age, gender, and rationality that initiate appropriate social interaction and communication. Similarly, shape classifiers could prime features relevant to culturally important affordances and actions.

If classifiers participate in such forms of situated activity, many more neural systems are likely to be involved in implementing them than those that represent object features. In particular, systems that represent goals, actions, mental states, and outcomes may all enter into the distributed neural networks associated with classifiers, giving neuroscientists even more to do in understanding how classifiers operate in the cognitive system, together with the underlying neural mechanisms.

Importantly, it may be difficult to establish these distributed networks by only studying classifiers, words, and phrases out of context. To establish the complete neural systems underlying classifiers may require examining them in more complete contexts of situated action (e.g., Barsalou, 2016; Huettig, Rommers, & Meyer, 2011; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995).

6. Conclusions

As I hope has become clear, classifiers constitute a microcosm of important issues facing research on concepts. Following Kemmerer (2016), we will learn a lot about conceptual processing and its relation to language from better understanding them. We cannot understand the human conceptual system without taking classifiers into account, given their potential to shape it significantly.

Additionally, research on classifiers offers important opportunities for better understanding: (1) how conceptual features originate in the cognitive system, (2) how grounding, abstraction, and distributed linguistic representations work together to produce conceptual processing, (3) how general cognitive processes such as attention, repetition, and context-dependence contribute to language, and (4) how cognitive processes, including language, develop to support situated cognition and action.

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