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Comment

Language as a source of abstract concepts
Comment on "Words as social tools: Language, sociality and inner grounding in abstract concepts" by Anna M. Borghi et al.

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Borghi et al.'s ambitious contribution [1] covers a lot of ground: they delineate types of abstract concepts, review theories of word learning, relate abstractness to modality effects in learning and recognition, and most importantly, advance the argument that words are "social tools" that facilitate (or more strongly, *enable*) the learning of abstract concepts. I agree with Borghi et al. that we need to focus on language for understanding how we learn abstract concepts. But I worry that in framing the Words as Tools theory so firmly in the "embodied and grounded" approach to cognition (to which I am generally sympathetic), the theory risks being overlooked by researchers who do not already subscribe to this approach. Therefore, I would like to highlight the main reason why I think it is so important to look to language to understand abstract concepts, even for someone who does not embrace the embodied view. Briefly, words allow us to chunk sensory inputs in a way that is not possible by relying on (nonlinguistic) perception and action alone. In neural network terms, words are "targets" that supervise category learning.

Chunks and words

In his famous article on the human capacity for processing information, Miller [2] noticed that the magical number 7 (± 2) came up over and over in tests of discrimination and memory. This number enumerates *chunks*. What is a chunk? Miller does not say exactly, but he offers the example of someone learning Morse code. Initially, the learner is only aware of individual bits (dots and dashes). As the learner gains more experience, the dots and dashes become grouped into letters, then words, "which are still larger chunks". According to Miller, a simple way to perform this recoding is "to group the input events, apply a new name to the group, and then remember the new name rather than the original input event" [2]. The initially numerous chunks of "-- -.-- ... - . .-. .. --- ..- ..." are grouped into the single chunk "mysterious". But where did *that* chunk come from in the first place? We don't talk about chunks much these days. Instead, we talk about concepts and categories. But the same question applies.

One answer is to assume that like an adult learning Morse code, a child learning their first language already has all the requisite chunks and simply learns to map them onto words [3,4]. Certain broad distinctions – agent, patient, predicate – the kinds of meanings proponents of this view often discuss, may indeed exist in some form prior to language. But it is a far cry from these broad distinctions to the concepts that are the currency of our thought and

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language. We neither think nor talk about agents, patients and predicates. We *do* talk about anticipating a fun dinner, and about losing our keys and worrying about being late. The underlined words are all abstract. Indeed they are all more abstract (according to published norms [5]) than FREEDOM, that paradigmatic abstract concept. Where does a chunk like FUN come from? Might it be that it comes into being from observing a common label be used to refer to a variety of activities, situations, and people?

Borghi et al. briefly touch on the idea that "a unifying label can [work] as a sort of 'glue' keeping sparse experiences together..." (sect. 2.1) and "labels can help us to glue together the heterogeneous members of [abstract concepts]" (sect. 6). This important idea (which is not elaborated in the target article) is, I believe, *the* key to understanding the importance of language to category learning, and especially to the learning of abstract categories. If it were the case that the world provided learners with neatly packaged chunks (i.e., categories), life would be easy. People could learn the chunks from repeated interactions with the world. But the world does not come pre-categorized. All the excitement surrounding the latest advances in machine vision in categorizing images [6] often overlook the fact that success of these approaches depends on training that uses linguistic labels. Learning even concrete categories like jacket and speedboat without guidance from labels turns out to be extremely difficult because their members often do not cluster sufficiently on their own [7].

This problem becomes increasingly serious when we move to more abstract perceptual categories like RED THING. If the chunk RED THING seems perfectly obvious and natural [8], consider that this feeling may come from having long ago learned the requisite labels – both the specific label "red" and a more general dimensional attribute term "color" – which then lead to our representing color as a dimension abstracted away from shape, function, location, etc. Lacking color names certainly does not make us color blind (our ability to discriminate colors is what makes these terms possible in the first place), but it does make forming this type of category not nearly as natural [9–13]. Even in adult English speakers, subtle verbal interference makes forming such categories more difficult [14] while exaggerating labels appears to perceptual warp the color space making categorical distinctions more salient [15]. As we move up the abstraction hierarchy, the commonality between category members keeps shrinking, and our dependence on the label for cohering the category keeps growing.

Learning from language: distributional learning, words as glue, and the grounding problem

One way for a label to cohere a category is by having otherwise completely disparate perceptual experiences associated with a common response (the label). This idea, first articulated by William James [16] seems to be what Borghi et al. have in mind when they write about labels acting as "glue." But another way is for the label to cohere otherwise disparate *linguistic* expressions. What is being "glued" here are linguistic expressions themselves. For example, hearing about people "dabbling" in writing, politics, and skiing allows us to derive a meaning of "dabble" through gradual alignment of the linguistic contexts in which the word appears. Importantly, the learner is not mapping "dabble" onto a pre-existing mental state, but inducing a new category (a new chunk) from language itself [17].

Borghi et al. seem to dismiss this process (often referred to as distributional learning) as "disembodied" (sect. 3.1.9), and limited by the symbol-grounding problem: "to allow full comprehension of meaning the symbols need to refer to their referent, and not only to other symbols" (sect. 4). But we need not restrict distributional learning to learning word-to-word associations. Rather, we can view language as a source of information that helps in constructing a (much) richer semantic network than we could construct otherwise. So rich is the structure conveyed by language that congenitally blind people are able to make semantic judgments about the meanings of words like "glimpse", "sparkle", and "glimmer" that are difficult to distinguish from judgments of sighted people [18]. Much of the information contained in language relates directly to perception and action (because we often talk about what we perceive and do). But language also bursts with abstract concepts: chunks that have emerged over millennia of cultural evolution. Learning these helps to make us fully human.

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