

Grounding Meaning in Affordances

Arthur M. Glenberg
University of Wisconsin — Madison

Consider which of the following sentences is sensible, and which is less so:

- 1a. *After wading barefoot in the lake, Erik used his shirt to dry his feet.*
- 1b. *After wading barefoot in the lake, Erik used his glasses to dry his feet.*

Sentence 1a is sensible, whereas sentence 1b does not make much sense. But why? Both sentences are grammatical. Both meet obvious semantic constraints (e.g., shirts and glasses are inanimate). Both sentences generate coherent, integrated, well-formed propositions. Finally, the sentences do not differ in the associations among the terms. That is, both “shirt” and “glasses” are associatively unrelated to “dry.”

The ability to discriminate between sentences such as these is taken as support for the Indexical Hypothesis. The hypothesis is based on three claims about how we understand words and sentences. First, words and phrases are indexed to objects in the world or to analogical representations of those objects such as pictures or perceptual symbols (Barsalou, under review). Second, we derive affordances from the objects. Third, and most importantly, the affordances, not the words, constrain the way ideas can be coherently combined or meshed.

Affordances (Gibson, 1979) are ways in which a perceiver with a particular type of body can interact with an object. For an adult, a chair affords sitting, standing-on to change a light bulb, and throwing to use as a weapon. For a child, a chair affords sitting and standing on (to get to the cookies), but not throwing. For an agile person, a floppy disk affords grasping and it affords scratching. A thread also affords grasping, but it does not afford scratching. Because we use affordances to understand sentences, we judge a sentence such as “Danielle used a small floppy disk to scratch her back” as sensible and understandable: Everyone knows that a floppy disk can be used to scratch one’s back even if no one has ever tried it or read about it. Similarly, everyone knows that the sentence “Danielle

used a short length of thread to scratch her back” does not make much sense.

According to the Indexical Hypothesis, grammatical constructions direct the combination, or mesh (Glenberg, 1997), of affordances through a process of envisioning. That is, if we can envision how the combination of affordances can accomplish the goal described by the sentence, then we understand the sentence and judge that it makes sense. Because humans can grasp and manipulate a floppy disk, and because floppy disks are rigid enough to afford scratching, we can envision how Danielle can use the disk to scratch her back. In contrast, because short lengths of thread are not rigid enough to afford scratching, we can make little sense of the alternative sentence.

Consider another example taken from a compass learning task used in one experimental investigation of the Indexical Hypothesis. In using a compass to identify landmarks, one step is “Point the direction of travel arrow at the mountain.” Comprehension of this sentence requires an understanding of what it means to point, but how one points depends in part on the affordances of what one is pointing with. It means one thing to point an index finger, another to point a rifle, another to point a car, and quite another to point a direction of travel arrow. Do we have in memory a huge listing of what it means to point, and select the appropriate meaning based on a search of memory? Perhaps, but consider this alternative. Our knowledge consists of a general notion of what it means to point (aligning the long axis of an object with a reference, or to-be-pointed-at, object). Also, we have a repertoire of bodily skills, such as how to grasp and turn objects of different sizes and hefts. To understand the sentence about pointing the direction of travel arrow, we need to index the words (“direction of travel arrow”) to the actual object so that its affordances are made available. Then, we can mesh our general knowledge of pointing, the affordances of the direction of the travel arrow, and our repertoire of bodily skills to envision

a coherent set of actions that result in pointing the direction of travel arrow at the mountain.

In contrast, if we did not know the affordances of a direction of travel arrow, then we could not comprehend the sentence: We would not know how to act on it. Or, if a direction of travel arrow did not afford pointing (like the glasses in 1b do not afford drying), then the sentence would be nonsense. For example, if a direction of travel arrow was a vector that indicated the mean direction and duration in which one had been walking, it is not clear what it would mean to point this vector at a mountain. Although the vector has a direction, it is not something that can be changed by the usual actions of pointing.

The Indexical Hypothesis has several implications for meanings of words. First, language understanding requires that the affordances of objects be readily available. In turn, this requires that a component of word meaning be an analogical representation such as a perceptual symbol. That is, word meaning cannot be restricted to descriptions using arbitrary symbols and their relations. Although the descriptions may provide affordances for how an object is used in some situations, an analogical representation is needed to derive affordances for how the object might be used in novel situations, such as using one's shirt to dry one's feet, or using a floppy disk to scratch one's back.

The indexical hypothesis has been tested in several different types of experiments. In one experiment, participants were asked to judge the meaningfulness of sentences such as 1a and 1b. Of course, people were quite good at this. Interestingly, the time it takes to read sentences such as 1a was no longer than the time to read a control sentence such as 1c.

1c. After wading barefoot in the lake, Erik used his towel to dry his feet.

This result demonstrates that people do not treat 1a as unusual. It also demonstrates that the affordances of shirts (that they can be used to dry feet) are not derived from a long chain of inferential reasoning. Instead, the fact that a shirt affords drying is as readily available as the fact that a towel affords drying. The point is that using affordances is not a special or unusual comprehension strategy; it may well be the norm.

In a second type of experiment, participants were asked to learn (from reading) how to perform a new task, using a compass and map to identify landmarks. In the first part of the experiment, participants learned background information about parts of a compass, such as the direction of travel arrow. Participants in the Index group were given the opportunity to index terms to an actual compass. Participants in the Read group were given the opportunity to reread the background

information. The Read group performed slightly better than the Index group on a verbal test of the background information. In the second phase of the experiment, the two groups read instructions for how to use the compass, such as "Point the direction of travel arrow at the mountain." The participants in the Index condition read the new instructions about 25% faster than the participants in the Read condition. Furthermore, the Index participants performed the task significantly more accurately. Thus, indexing words to objects in the first phase of the experiment greatly facilitated comprehension of instructions regarding those objects during the second phase of the experiment.

References

- Barsalou, L (under review). Perceptual symbol systems.
- Gibson, J. J. (1979). *The ecological approach to visual perception*. New York: Houghton Mifflin.
- Glenberg, A. M. (1997). What memory is for. *Behavioral and Brain Sciences*, 20, 1-19.