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Philosophy 189

Augmenting Minimalism: A "Deep Prototype" Theory

Strevens (2000) argues and defends (2001a and 2001b) "causal minimalism," a theory of naïve natural kind categorization in which people make categorization decisions based solely on causal laws, without appealing to "essences." Specifically, he describes "K-laws," which are statements of the form "all K's have P," where K is a category and P is a property. Strevens' theory is an attractive alternative to essentialism, but, as he admits himself, "minimalism must make certain assumptions about people's naïve theories" in order to be meaningful (2001a, p. 74). I shall elaborate and extend on Strevens' assumptions, positing a "deep prototype" theory to allow minimalism to explain data it could not otherwise.

What data does minimalism not explain? Specifically, minimalism does not adequately distinguish between those properties of natural kinds that are more relevant to categorization and those that are less relevant to categorization. For example, Ahn (1998) cites a number of studies that show how changes in molecular structure (e.g. chromosomes in biological kinds) were more likely to influence subjects' categorization of natural kinds. I ran a similar, informal experiment on five subjects to gauge their categorization on natural kinds, modeled on Keil's (1989) experiments on "transformations" from raccoons to skunks:

Method

Five subjects were recruited by skillful enticements of making a contribution to science. Each was presented, either orally or on paper, with a set of situations involving a scientist who performs various operations on a raccoon. (See Appendix for a list of the situations.) After each situation, subjects were asked to rate to what extent the resulting animal "is a skunk"—either marking on a written Likert-like continuous scale between "Definitely" and "Definitely not," or responding orally on a scale from 1 = "Definitely not" to 10 = "Definitely." Written answers were converted to the 1 to 10 scale using a ruler. As in Keil (1989), subjects were asked to explain their reasoning.

Results

Subjects, like those in Keil's study, refused to believe that spraypainting a stripe on a raccoon and adding a "skunk smell" would make it a skunk (all rated this as a "1," or "definitely not" a skunk). As the racoon's organs were gradually replaced, however, subjects were more and more willing to say that it "is a skunk." Several subjects were especially committed to the importance of the brain: Indeed, two people refused to budge from a "1" rating until it was replaced. As one said, "The brain is the key! Does it think like a skunk?" After all the raccoon's organs and skin were replaced with those of a skunk, every subject but one rated it as "8" or "9" (i.e. close to "definitely a skunk"). Several subject noted that it would retain a raccoon's skeletal structure, and thus did not rate it a "10." Subjects were generally unconvinced by the replacement of reproductive DNA, rating it an average of 1.8; however, replacing all DNA was rated higher (4.6).

The final question, involving DNA replacement and speeding up of metabolic processes, was rated an average of 7.2, nearly as high as the "replacement of organs and skin" case.

Discussion: Implications for Minimalism

There definitely seem to be some features (e.g. the brain) that are more important to categorization of natural kinds than others (e.g. skin). How can minimalism attempt to explain this? Recall that minimalism sets up a series of K-laws, such as "All raccoons have bushy eyes" and "All skunks smell." Also recall that, in the absence of relevant, contrary causal data, minimalism suggests that we make our categorization decisions solely on the basis of "characteristic observable properties" (Strevens 2001a, p. 74).

Minimalism easily explains the "surface change" case (question #1), in which the raccoon is made to look and smell like a skunk: While its surface properties are identical to that of a skunk, we know that these properties (smelliness, having a stripe, etc.) are caused not by "being a skunk" but by the scientist's having painted them on. That is, the K-laws for skunks are not invoked as causally important, as we have another explanation for what caused the skunk-like surface properties.

However, minimalism—at least unaugmented by assumptions beyond those articulated in Strevens (2001a)—does not account for why people are much more likely to call the animals in later questions "skunks." As in the "surface change" case, one has an alternate explanation for all the observable properties: they are skunk-like not because the animal "is a skunk," but rather because a scientist added them. In particular, minimalism does not explain why replacing one property—such as skin—is less important to categorization decisions than another—such as the brain or other internal

organs. There is no inherent reason why minimalism should treat these traits any differently—in fact, since the internal organs are generally not observable, one might argue that minimalism holds that they do not play a role in categorization!

A minimalist might reply, "Well, the subjects know that the skunk organs, skin, etc. all came from a *real* raccoon, and thus the K-laws hold for the transplanted parts. That is, they have their properties because they *are* skunk organs. Thus, the more of these parts that you add to the raccoon, the more the skunk K-laws take hold." This is a tempting theory, as it does not need to posit any additional assumptions about categorical reasoning. However, this *still* doesn't explain why some "skunk parts" (such as the brain) are more important than others.

Ahn's Alternative

Ahn (1998) proposes an alternative theory, the "causal status hypothesis," in which features that are more causally central are more important to categorization. In simple terms, "cause factors" are more important than the "effect factors" that they cause. This might partially explain the importance of the brain, as it causes all (or almost all) behavioral features of a biological category. However, the causal status hypothesis does not explain the importance of other internal organs over skin—the observable skin property does not causally depend on internal organs.

Ahn also seems committed to essentialism; in Ahn et al. (2001), she and her co-authors argue that people hold essentialist beliefs, and that essentialism explains this "feature centrality" of cause factors while minimalism does not. If people hold any essentialist beliefs about biological kinds, it is likely to be that DNA is that essence;

however, the questions about DNA replacement revealed that only when the DNA begins to change the raccoon organs into skunk organs were a majority of the subjects willing to classify the animal as a skunk. That is, changing the DNA (the putative essence) was not enough: one has to make that change tantamount to the organ transplant example before people will commit to the animal's "skunkhood." If the essentialist theory is correct (and if people do indeed believe that DNA is the basic biological essence), then changing the DNA in the first place should have been enough to sway the subjects.

Augmenting Minimalism

I propose to augment minimalism so that it can account for differences between different properties in the categorization of natural kinds: In place of Strevens' assumption about "characteristic observable properties" of a natural kind we do the following:

- Take the entire set of observable properties of a natural kind K ("observable" including those properties which are not at the "surface" level yet are observable to science, such as internal organs)
- For each property P, we assign a weight W based on its importance to that category
- For each P, we posit a K-law that "all K's have P," adjusted by W (that is, if W is low, then we are less committed to the idea that *all* K's have P)

The extent to which an object we want to classify corresponds to these weighted K-laws then determines whether it will be classified as an instance of K. Because the weights are similar to those proposed by prototype theory, I call the weighted K-laws the "deep prototype." In place of essentialism's potentially-unknowable "essence" (Figure 1), we augment basic minimalism (Figure 2) with an additional module which helps define what it is to be part of a category—in this case, what it is to be a skunk (Figure 3). (Note that the weights of the lines emanating from the deep prototype correspond to the weights— thus, having a skunk brain is weighted higher than being smelly or striped.)
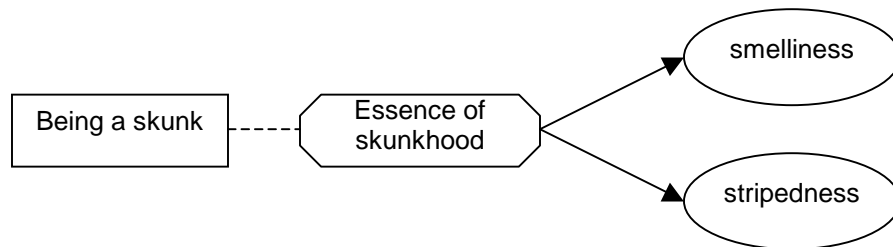

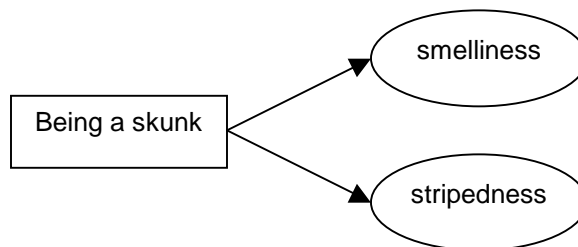Figure 1: Essentialism (based on Strevens, 2000)
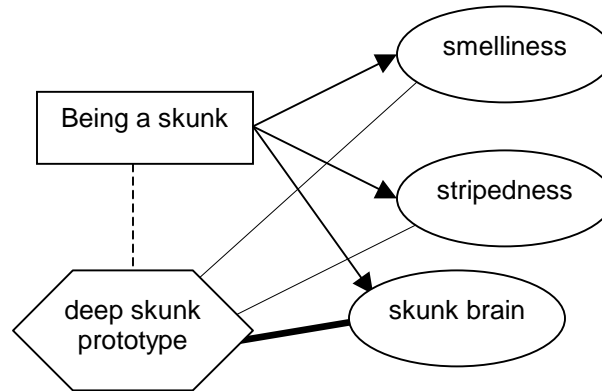

Figure 2: Basic Minimalism (based on Strevens, 2000)

Figure 3: Minimalism Augmented by Deep Prototype

Note that "deep" does not mean "less observable," nor does it (necessarily) mean more causally central, as in Ahn (1998). Rather, "deep" distinguishes this prototype from that of basic prototype theory, which *only* appeals to surface properties. Because the deep prototype retains the basic structure of minimalism, it escapes from prototype theory's failure to account for the Keil (1989) experiments: As in Strevens (2000), we can still appeal to causal reasoning to explain why people are not led astray by changes in surface properties.

How can one determine the weights used in the prototypes? Since we are attempting to model how people make categorization decisions, we can run empirical tests (such as the informal experiment described above) to determine how important various properties are to various categories. For example, having a human brain may be especially important to being classified as a human (as opposed to another primate), but having a sparrow brain might be less important to being classified as a sparrow (as opposed to another bird).

Conclusion

  Thus, while basic minimalism fails to adequately explain some of our categorization decisions about natural kinds, one can add an additional assumption to the theory—namely, the existence of a deep prototype—which increases minimalism's explanatory power without diminishing its other strengths. An enterprising philosopher-cognitive scientist might be able to extend deep prototype minimalism to cover all natural kinds, and perhaps even artifacts, thus explaining the work of human categorization with a parsimonious, yet empirically-grounded theory.
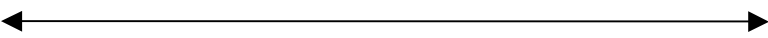
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Ahn, W., C. Kalish, S.A. Gelman, D. L. Medin, C. Luhman, S. Atran, J. D. Coley, and P. Shafto. (2001). Why essences are essential in the psychology of concepts: Commentary on Strevens (2000). *Cognition*, 82, 59-69.

Keil, F. (1989). *Concepts, kinds and conceptual development*. Cambridge, MA: MIT Press.

Strevens, M. (2000). The essentialist aspect of naïve theories. *Cognition*, 74, 149-175.

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Appendix: Experiment Questions

Place an X on the line where you feel it should be…feel free to write in why you think what you think (or just tell the experimenter as you go along).

A scientist takes a raccoon, and spraypaints a white stripe on it, and implants a "skunk smell"-producing device into it. It now looks and smells exactly like a skunk.

Is it a skunk?

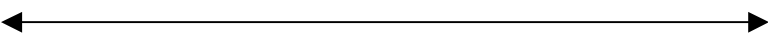 Definitely ◄————————————————————————————————► Definitely not

A scientist takes another raccoon, removes its skin and replaces it with skunk skin, and transplants a "skunk smell"-producing organ from a skunk. It now looks and smells exactly like a skunk.

Is it a skunk?

  Definitely ◄————————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces all of its internal organs (heart, lungs, liver, etc.) with skunk organs, except for its brain. However, on the outside, it still looks like a raccoon.

Is it a skunk?

  Definitely ◄————————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces all of its internal organs (heart, lungs, liver, etc.) with skunk organs, including its brain. However, on the outside, it still looks like a raccoon.

Is it a skunk?

  Definitely ◄————————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces all of its internal organs (heart, lungs, liver, etc.) with skunk organs, including its brain. The scientist also replaces its skin with skunk skin. It now looks exactly like a skunk.

Is it a skunk?

Definitely ◄————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces its reproductive DNA with skunk DNA, such that if it mates with a skunk, the two animals will produce a skunk. On the outside, it still looks like a raccoon.

Is it (the animal whose DNA was replaced) a skunk?

Definitely ◄————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces *all* of its DNA with skunk DNA. On the outside, it still looks like a raccoon.

Is it a skunk?

Definitely ◄————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces *all* of its DNA with skunk DNA. The scientist also replaces its skin with skunk skin. It now looks exactly like a skunk.

Is it a skunk?

Definitely ◄————————————————————————————► Definitely not

A scientist takes another raccoon, and replaces *all* of its DNA with skunk DNA. The animal is given a treatment to speed up its metabolism, such that the new DNA will cause its skin and other organs to gradually be replaced with skunk skin and organs.

Is it a skunk?

Definitely ◄————————————————————————————► Definitely not