REPLY TO OSTAREK ET AL.:

# Language, but not co-occurrence statistics, is useful for learning animal appearance

Judy S. Kim[a,1], Giulia V. Elli[a], and Marina Bedny[a]

In our original paper (1), we report that people born blind share a great deal of knowledge about animal appearance with people who are sighted. Verbal communication is likely an important vehicle for transmitting this knowledge. A crucial question, however, is exactly how blind individuals learn about appearance from language. Although sighted people, when instructed to do so, verbally describe the colors of animals more easily than other dimensions (e.g., shape), blind people agree more with the sighted and with each other on animal shape and texture than on color. Shape and texture, but not color, are partially predictable from taxonomy, and we suggest that blind individuals infer appearance from kind rather than relying solely on stipulated facts about appearance.

Ostarek et al. (2) suggest that blind individuals might still learn primarily by memorizing appearance facts, but that the facts sighted people describe are inaccurate. They present an analysis of word co-occurrence in a spoken language corpus (OpenSubtitles) (3) and find that many animal words co-occur more or equally frequently with noncanonical as compared to canonical colors. For example, "elephant" co-occurs more frequently with "white," "pink," and "blue" than with the canonical color "gray." In many cases, the most frequently occurring color is an exception to the rule (e.g., black sheep). Frequently occurring colors also include cultural associations such as brand names ("Red Lion Hotel") or cartoon characters (e.g., Pink Panther), or even the color of a substance produced by the animal (e.g., pink milk for hippos) (see Fig. 1 for more examples). By contrast, when asked to report the actual colors of animals, sighted people almost always provide the canonical colors (1). This useful analysis demonstrates that co-occurrence statistics are not an accurate reflection of sighted people's color knowledge. Importantly, co-occurrence statistics also do not correspond to the knowledge of people born blind. Although blind people's knowledge of animal color is more variable than that of the sighted, in a naming task blind participants are still more likely to provide canonical over noncanonical colors (Fig. 1) (1).

We hypothesize that blind individuals use rich, theory-like linguistic, conceptual, and social knowledge to make inferences based on language (e.g., refs. 4–6). This includes making inferences about appearance from taxonomic kind but also interpreting appearance descriptions in sophisticated ways. Hearing "red panda" or "this crow is white" conveys something different from "pandas are black and white" or "crows are black" (7). Similarly, "Red Lion Hotel" and "hippos make pink milk" tell us something different from "lions are gold" and "hippos are gray." Ostarek et al.'s (2) analysis provides an illustration of how human learning from language is very different from co-occurrence tracking.

[a]Psychological and Brain Sciences, Johns Hopkins University, Baltimore, MD 21218

Author contributions: J.S.K., G.V.E., and M.B. wrote the paper.

The authors declare no competing interest.



[1]To whom correspondence may be addressed. Email: judyseinkim@gmail.com.

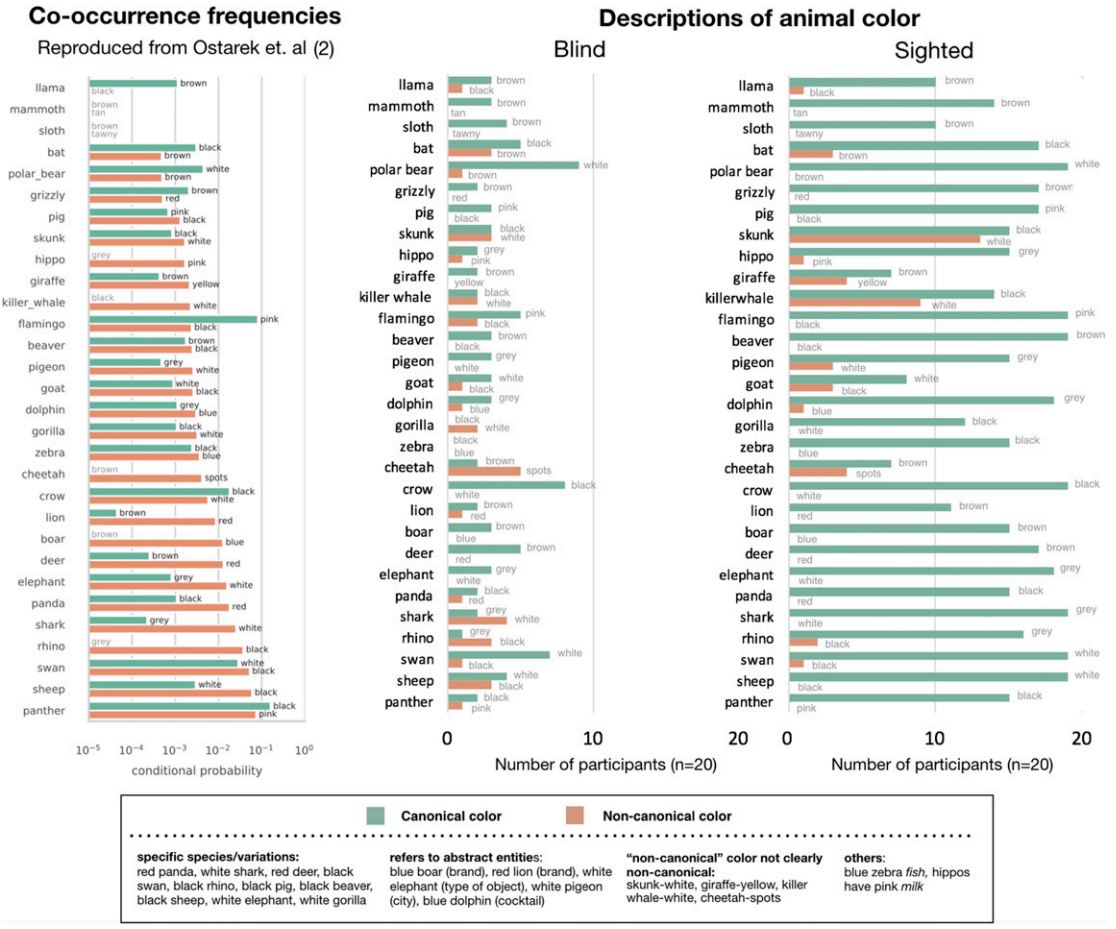


**Fig. 1.** (*Left*) Co-occurrence frequencies for animals and colors (reproduced from ref. 2). (*Right*) Blind and sighted participants' descriptions of piles created during sorting animals by color (data from ref. 1). Counts are shown for canonical color (color most frequently provided by sighted) and "top" noncanonical color. Full distributions over all colors for both co-occurrence and participant-generated labels can be found at https://github.com/judyseinkim/Animals.


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