Time to vary the formula
Commentary on **Marino & Merskin** on *Sheep Complexity*

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Abstract: In the past few years, Marino and her colleagues have written a series of comprehensive and helpful review articles on the cognitive, emotional, and social complexity of pigs, chickens, cows, and most recently, sheep. These articles are similarly structured, even formulaic, which has benefits but also limitations. Here, I point out the limitations in order to suggest new directions and contributions for the authors in the future.

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The target article by Marino & Merskin (2019) is a valuable addition to animal studies, with many good points. As a thorough review, it assembles a large amount of necessary information about sheep, which are less familiar (in North America at least) than are other farm and pet animals. It succeeds in its goal of showing that sheep are sentient and more cognitively sophisticated than most people recognize, and that they have individual personalities. I appreciated the evidence that sheep experience emotions, a topic in which I am particularly interested (Feinberg & Mallatt, 2016, 2018; Mallatt & Feinberg 2017). The target article is remarkably well written and clearly expressed. It will help policy makers and those involved in sheep management, and will stimulate further research to improve the treatment of sheep. I liked the colorful, historical approach that was used to show how sheep are especially harmfully stereotyped, as docile, dull, and pliant followers; from this, **Baker** (2019) made the case that sheep suffer more from their stereotype than do other domestic animals.

While reading the target article, I kept looking for recommendations on how to help sheep specifically, as opposed to the other farm animals whose treatments could also be improved. I could not detect any such recommendations. This led me to examine the paper's organization and to suggest some new directions for Marino and her colleagues in their future work.

After the sheep paper, I read their other recent review articles, on cows (Marino & Allen, 2017), pigs (Marino & Colvin, 2015), and chickens (Marino, 2017). I detected a uniformity that is both beneficial and confining. The formula is: first each paper says that our stereotypic characterizations of the species (or subspecies, or domesticated variety, etc.) are wrong, then that this species has largely unrecognized capabilities within the categories of classical animal psychology and behavior, while presenting the literature that documents each of these capabilities. Finally, a Conclusions section summarizes the findings, says these findings break the simplistic stereotypes, so the species merits better treatment by humans.

This formulaic approach has its benefits. First, it yields strongly supported arguments whenever the literature clearly upholds the claim for complex cognitive, social, and individualistic traits in the species of interest — which is usually the case. Second, the approach allows a vast amount of literature to be presented in an organized and easily understandable way. Third, it makes the articles easy to write because the same category descriptions are used over and over, in paraphrased form, in much the same order in every article (e.g., a paragraph that defines personality; one that introduces emotions; one that defines cognitive bias, etc.).

But the formula also has weaknesses that lead to pitfalls. The rigid 'list-building' makes it difficult to write an analytical, critical, in-depth review of the literature. This was a complaint in the commentary by **Vonk** (2019). Next, it is difficult to include any of the important literature that does not fit into the precise categories of the formula. The formula also forces one to write about those categories for which too few studies are available, and to shoehorn certain studies into categories that they do not fit or support. For example, the topics of emotional contagion (p. 11) and the joy of learning (p. 10) in sheep show this strain, leading to Vonk's comment that the support offered for emotional contagion did not really fit.

The formula approach carries the temptation to include mostly the *positive* evidence that the species fits the category, and to underplay the literature that found counterevidence or a lack of evidence. With so much emphasis on finding the similarities, it is easy to miss the differences. It seems too strong to call this "cherry picking" (as **Vonk** does) — after all, most of the evidence validly supports the claims. But it is striking how little contrary evidence is presented in the series of papers. This gives one the false impression that all four species have, and share, almost every essential trait. So how can we tell how sheep, cows, pigs, and chickens differ, which we must know in order to meet the special welfare needs of each? We are not explicitly told how, even in the Conclusions sections.

To illustrate this point further: for sheep it was *the commentators* who had to present the special features (**Adolphs**, 2019; **Horback**, 2019; **Phillips**, 2019; **Webster**, 2019; **Woodruff**, 2019). Phillips did an especially good job of relating sheeps' lack of aggression, and thus their vulnerability to mistreatment by humans, to the ease with which their ancestors could escape predators (through "agility . . . jumping between rock ledges"), without having to fight back. Horback did a fine job of using sheeps' special features to make specific suggestions for improving their treatment: e.g., during stressful sheering and in birthing.

It is ironic that Marino and colleagues so strongly advocate the need to see individual animals as distinct, yet they don't treat the different species as distinct with unique welfare needs. I have argued that they are trapped in a formula that caused this blind spot.

Here are some recommendations for any future review articles in the series. Keep the good parts of the formula, but modify it enough to allow deeper, more critical analyses, and identify each species' unique features to recommend more species-specific improvements in their treatment. A future paper might combine all the farm animals in this truly comparative light, comparing and contrasting their needs. This might yield, for example, something along the lines of Grandin's (2013) recommendations for optimal design of slaughterhouses, but with different recommendations for cows versus sheep versus pigs.

My Commentary is not meant to be too harsh a critique of a fine paper that succeeded in its stated goals. It is mainly meant to provide suggestions for fruitful new directions.

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