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Special Issue on Categorization: Causes and Consequences

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The Canadian Society for Brain, Behaviour and Cognitive Science (CSBBCS) is the face of behavioral neuroscience in Canada. With a broad outlook on experimental psychology, it appeals to students and their supervisors from across the country and beyond. While we all have much in common, there are also some obstacles to communication, not the least of which are the human/other-animal divide, and the various methods and theoretical perspectives we hold. An ecological approach connects seemingly disparate areas by opening our eyes to both causal and functional questions: we have not completely understood behavior unless we grasp its function, evolution, proximate causation and development—i.e., answers to all of Tinbergen's four questions "What is it for? How did it evolve? How does it work? How did it develop?". While none of this is news to readers of the *International Journal of Comparative Psychology* (IJCP), it is still not common currency in Psychology today. This is all changing. Indeed, CSBBCS awarded the Donald O. Hebb distinguished contribution award to Dr. Sara Shettleworth in 2012 for her lifetime contributions to "Cognition, Evolution and Behavior". The 2016 meeting of CSBBCS, organized by Dr. Charles Collin, included a symposium on "Categorization: Causes and Consequences" aimed at pursuing this approach and bringing together researchers who otherwise might not have had a chance to exchange ideas. Dr. Dani Brunner, editor-in-chief of IJCP at the time, had suggested that a symposium might be paired with a call for papers and turned into a special issue. Here it is.

Symptomatic of the obstacles to integration of research areas within Psychology is how our interests are identified. In non-human animal learning and cognition, researchers are often identified in terms of the creatures that they study, be they food storing birds, whales, or hyenas. In my own department, where I study the processes underlying floral recognition in bumblebees, I am sometimes known as the Animal Behavior person, the Bee-Lady, or, on good days, 'The Queen Bee' — never mind that bumblebees alone comprise about 250 species worldwide. In contrast, human psychology is typically carved up along thematic lines. Again, in my department, we have a psycholinguistics person, a computational modeler, an expert on evoked potentials etc. Of course, these are all just short-hands. Nonetheless, they all fail to capture the nature of behavior as a solution to a problem. In this issue, we look at categorization as an integral part of the solution to a variety of problems.

What do we mean by categorization? It will come as no surprise that there is no general consensus. Here, we cast a wide net. There was no attempt to second guess the authors and argue about definitions, such as whether categorization presupposes language or how concepts differ from categories. We assumed nothing more than that animals regularly confront fitness-relevant problems such as getting enough to eat, finding shelter, attracting a mate, recognizing an ally, or avoiding a predator, and that there is naturally occurring variability in the presentation of the relevant stimuli. We examine how animals behave appropriately under these circumstances.

The ordering of the papers below explicitly disrupts the highly misleading Scala naturae—the ladder of continuous evolutionary progress—according to which we should have started with bees and their ostensibly simple minds, then progressed to miscellaneous birds and mammals, and ended with *Homo sapiens*. Instead, the papers are very roughly organized according to their relative emphases on function, evolution, mechanism, and development.

The stage is set by Sturdy, Campbell, Congdon, Hahn, McMillan, and Scully (2017) in an extensive review of a comprehensive research program on vocal communication in songbirds. From early days in which key acoustic features were identified and operant methods, which are used to this day, were developed, research has come to be supplemented with what we can learn from artificial neural networks and investigations of gene expression in the brain. Can songbirds, with their 'bird brains', classify songs according to geographic origin? Can they assess dominance and track it across seasons? Can they perceive abstract relations? Detect threat levels posed by various predators? And if so, how? Recent efforts to answer these questions are reported and the news is most encouraging.

The importance of functionality in vocal call usage is taken up again by Vergara and Barrett-Lennard (2017), this time in marine mammals. In their pain-staking work with Qila, a beluga at the Vancouver Aquarium, categorical matching was investigated. Qila was able to respond to playbacks of *pulse-trains* with vocalizations that matched the category. No such success was obtained with *screams*—a signal that is not part of the natural repertoire of belugas. The thoughtful and insightful discussion in their paper highlights a host of methodological issues in this area and the role of contextual learning in natural settings.

In our own species, categorization of emotions on the basis of visual cues in facial expressions can serve to regulate emotions and guide social behavior. Ziebell, Collin, Weippert and Sokolov (2017) examine categorization of facial expressions in young people with a history of non-suicidal self-injury. Compared to controls, this group showed heightened sensitivity to negative emotions—those that may signal social rejection or threat—but not to positive emotions. For instance, anger was recognized at a lower intensity of facial expression and fear was categorized more accurately. Connecting the dots through categorization, emotion, behavior and health consequences is an enterprise that is to be welcomed by evolutionary psychologists and clinical practitioners alike.

In a literature review of categorization in carnivores, Vonk and Leete (2017) present recent advances in understanding categorization in a variety of organisms with sharp teeth, including bears, hyenas, raccoons, lions, tigers, cats and dogs. Needless to say, there are methodological challenges here too. By examining whether some species excel in specific domains or across domains, we are offered a glimpse of how questions about the evolution of cognition can be addressed. For instance, the Social Intelligence Hypothesis and the Technical Intelligence Hypothesis emphasize different possible selection pressures. To quote the authors, categorization in carnivores most assuredly "bears" further study.

An empirical study by Feuerbacher and Rosales-Ruis (2017) on a particular carnivore, Aero the German Shepherd, shows that domestic dogs can distinguish between two classes of objects, toys and non-toys, in their everyday lives. How can dogs learn to categorize new objects? By virtue of a common response. Previously non-retrieved objects could be added to the class "toy" by engaging Aero in bouts of tug-of-war with them. What's more, the real value of categorization was illustrated by training the dog to emit a new response to one member of the class. Aero reliably subsequently emitted this response to all the other toys. These results home in on the specific interactions between animals and their natural environment that give rise to concept formation, including interactions with human beings.

Bumblebees foraging on rewarding flowers face seasonal changes in blooming periods. A floral species that was rewarding yesterday may not be so anymore today. Xu and Plowright (2017) ask the same question of the behavior of bees as was asked, above, about domestic dogs: if the reward contingency for one member of a class changes value, are the other members treated as also having changed? In short, yes. The study of categorization in invertebrates, which has in recent years come to include not only perceptual classifications but also abstract relations, defies descriptions of cognitive processes as being simple or complex just by virtue of brain size or the position of a species on a phylogenetic tree.

In the traditions of associative learning and the experimental analysis of behavior, Plazas and Cortés (2017) had preschoolers learn matching to sample tasks using arbitrary visual patterns and colors and arbitrary auditory stimuli (e.g., "troma", "zife"). They examined the formation of *stimulus equivalence classes*, which is evident by new emergent relations that were not explicitly trained: the mathematical properties of reflexivity, symmetry and transitivity. Their question for developmental psychologists was this: what are the pre-requisites for the formation of an equivalence class? One possibility is exclusion performance— selecting an undefined comparison stimulus in the presence of an undefined sample—which in turn is associated with the vocabulary spurt in toddlers. The results showed some modality dependence. A process-level account will likely defy simple generalizations.

The comparative approach comes into its own in a contribution to the study of development by Phillmore, Fisk, Falk, and Tsang (2017). Here, we consider vocalizations again: infant-directed song and speech, which are perceptually categorized by 6- to 9-month old infants. An ingenious way of assessing the discriminability of the acoustic stimuli was used. Speech and song fragments, in English and in Russian, were presented to *unbiased acoustic experts*: zebra finches. The finches learned to distinguish between song and speech in both languages and could classify new exemplars. In their judgment, Russian vocalizations were not inherently easier to classify than English, though the children of English speaking mothers had a preference for Russian. Female zebra finches seemed slightly more adept at auditory discriminations than males, which may be important in their use of male song in their mate selection. On this "note" ends a necessarily brief and selective overview of just some of the highlights of current research on the many facets of categorization.

This issue captures the richness of behavior of several species, including our own, and the creativity of the researchers grappling with the causes and consequences of categorization, but the literature reviewed is by no means exhaustive. Much has been written on categorization, and we could not even begin to do it all justice here. It is my hope that this special issue will generate just the right level of tension to prompt further reading, questioning, theorizing, experimenting and debate and that it will also serve to further broaden and strengthen the appeal of Comparative Psychology. Perhaps the reader will one day envisage spearheading a new special issue, Categorization—the Sequel, to appear on our reading lists in the very near future.

At the time of writing this introduction, I regret some possible omissions in the list of contributions above. A few manuscripts remain in the pipeline, and I expect that they will soon take up their place in this special issue. While they are not summarized here, they are most certainly a source of enrichment for this issue and fit seamlessly in the framework above.

Acknowledgments

References

Feuerbacher, E. N., & Rosales-Ruiz. (2017). Can dogs learn concepts the same way we do? Concept formation in a German shepherd. *International Journal of Comparative Psychology*, *30*, 1–25.

Phillmore, L. S., Fisk, J., Falk, S., & Tsang, C. D. (2017). Songbirds as objective listeners: Zebra finches (*Taeniopygia guttata*) can discriminate infant-directed song and speech in two languages. *International Journal of Comparative Psychology*, *30*, 1–17.

Plazas, E. A., & Cortés, D. (2017). Relation between exclusion and stimulus equivalence class formation in auditory-visual and visual-visual matching in preschoolers. *International Journal of Comparative Psychology*, *30*, 1–19.

Sturdy, C., Campbell, K. A., Congdon, J. V., Hahn, A. H., McMillan, N., & Scully, E., N. (2017). Moving from perceptual to functional categories in songbirds *International Journal of Comparative Psychology*, *30*, 1–14.

Vergara, V., & Barrett-Lennard, L. (2017). Call usage learning by a beluga (*Delphinapterus leucas*) in a categorical matching task *International Journal of Comparative Psychology*, *30*, 1–20.

Vonk, J., & Leete, J. A. (2017). Carnivore concepts: Categorization in carnivores "bears" further study. *International Journal of Comparative Psychology*, *30*, 1–22.

Xu, V., & Plowright, C. (2017). A transferrable change in preferences of floral patterns by bumblebees through reward reversal. *International Journal of Comparative Psychology*, *30*, 1–13.

Ziebell, L., Collin, C., Weippert, M., & Sokolov, M. (2017). Categorization of emotional facial expressions in humans with a history of non-suicidal self-injury. *International Journal of Comparative Psychology*, *30*, 1–14.