

TO WHAT EXTENT IS THE ESTABLISHED CONCEPTUAL FRAMEWORK OF ANIMAL BEHAVIOUR USED IN TEXTBOOKS AND THE PRIMARY LITERATURE?

Subject/Problem

The American Association for the Advancement of Science (AAAS, 2010) stated in their *Vision and Change in Undergraduate Biology Education* report that alignment between biological undergraduate education and current research should exist. However, according to the National Research Council Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century (2003), biology curricula are not portraying current biological research frameworks, methods, and findings and instead are teaching future biologists biology geared toward the past. The committee recommends updating the curriculum, including curricular resources such as textbooks, to reflect our current understandings of biology. This basis includes both classical research that has set the current foundation and new research that has increased our understanding of the current science. Even AAAS (2010) acknowledges the limitation of current textbooks by suggesting that instructors go beyond the textbook and include primary literature in the curriculum.

Although the committee suggests that older scientific frameworks are being taught in the classroom, there is little published regarding the basis of curriculum, which is the textbook. Of the studies published on college biology textbooks, most examined specific topics such as aging (Krupka et al., 1980), Down syndrome (Bordson & Bennett, 1983), and pneumococcal type transformation (Baxby, 1989) instead of the discipline's fundamentals, such as cell theory. Furthermore, often the design of the study was either poorly created and/or described. For instance, rarely did any study attempt to validate the selection of their textbooks beyond choosing textbooks for a specific type of course (e.g., Baxby, 1989; Blackwell & Powell, 1995; Bordson & Bennett, 1983; Duncan et al., 2011; Gibbs & Lawson, 1992; Hughes, 1982). Some studies provided little information on the coding process (e.g., Baxby, 1989; Hughes, 1982).

Because undergraduate education should provide students the current biological research frameworks and because the discipline of animal behaviour established its framework 50 years ago, we examined how the framework of animal behaviour is portrayed in four popular animal behaviour textbooks. To determine if the framework is actually being used in current research, we also examined all research and review articles of 2013 from five animal behaviour journals.

Research Design

Our overarching research question is: to what extent is the established conceptual framework of animal behaviour used in textbooks and the primary literature? Textbooks and primary literature were examined via content analysis. The codes were based on the framework of animal behaviour, described in more detail below.

Animal Behaviour Framework. In 1963, Tinbergen revolutionized the study of animal behaviour by revamping the conceptual framework of the discipline. His framework suggests that any behaviour should be studied by answering all four of the following questions:

1. Causation: How does a behaviour occur? For instance, what triggers the display of tail feathers in the male peacock?
2. Ontogeny: How did the behaviour develop during an individual's lifetime? For instance, is the peacock tail feather display a learned behaviour?
3. Survival Value: How does the behaviour affect survival and reproductive success? For instance, does the tail feather display impact the number of mating opportunities?

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4. Evolution: Why did the behaviour evolve? For instance, did the ancestor of the peacock also exhibit tail feather displays?

These questions are now referred to as “Tinbergen’s questions.” For simplicity purposes, in this paper, we will simply refer to each question as causation, ontogeny, survival value, or evolution. Since the established framework states that all four of the questions are to be utilized equally, then all four questions should also be equally covered in textbooks and primary literature.

Methods. Four of the most popular animal behaviour textbooks were examined using content analysis. Popularity was measured by randomly selecting two institutions from each state and Washington, D.C. Animal behaviour instructors from each institution were contacted for their syllabi. Because three states only had one institution that had an animal behaviour course, 99 syllabi were collected. From these syllabi, four textbooks were each named by at least 5% of the syllabi, and therefore, their most recent editions were used in this study: Alcock’s *Animal Behavior: An Evolutionary Approach* (10th ed., 2013), Dugatkin’s *Principles of Animal Behavior* (3rd ed., 2013), Breed’s & Moore’s *Animal Behavior* (1st ed., 2012), and Drickamer’s et al. *Animal Behavior: Mechanisms, Ecology and Evolution* (5th ed., 2002). For each textbook, the text was first broken down into sections (a section is a portion of the chapter that has been given a heading by the author(s) of the textbook). The order that the sections were coded was randomly selected. Each textbook was coded with Tinbergen’s four questions. The number of lines covering each question was quantified. When coding first began, inter-coder reliability between the primary coder and an animal behaviour expert was established for 24 (2%) randomly-selected sections. Then the primary coder coded the rest of the text. After every 300 sections (of 1200 sections total), 14 of the sections were re-coded to establish intra-coder reliability. Therefore, inter-coder and intra-coder reliability was established (i.e., at least 70% similarity) for 20% of the text. Finally, for each textbook, the frequencies of the four codes (i.e., Tinbergen’s questions) were calculated.

Journal articles were examined after textbook coding was complete. The five animal behavior journals with the highest 2012 impact factor and five-year impact factor (according to ISI Web of Knowledge Journal Citation Reports for 2012) were selected for analysis. These journals were *Animal Behaviour*, *Behavioral Ecology*, *Behavioral Ecology and Sociobiology*, *Behaviour*, and *Ethology*. From these journals, all research and review articles published in 2013 (849 articles) were analyzed via content analysis. Each article abstract was read in full in order to determine (1) which of Tinbergen’s questions the study was attempting to answer (hereafter referred to as “goal of the study”) and (2) which of Tinbergen’s questions was/were discussed at all, such as providing the larger context of the study, the implications of the study, as well as the goal of the study (hereafter referred to as “broader context”). For instance, if a study was creating a phylogeny of a specific behaviour because previous studies had not been able to find any fitness-related benefits of the behaviour, then the goal of the study is evolution and the broader context is evolution and survival value. Similar to textbook coding, inter-coder reliability was first established between the primary coder and an animal behaviour expert for 25 (3%) randomly-selected articles. Then the primary coder coded the rest of the articles. Afterward, 145 (17%) of the articles were re-coded to establish intra-coder reliability. After coding was complete, the frequencies of the four codes were calculated.

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Analysis and Findings

Textbooks. All four textbooks covered all four of Tinbergen's questions, but ontogeny and evolution were rarely discussed (Figure 1). Each textbook dedicated 10% or less of their text on evolution and less than 13% on ontogeny. Dugatkin (2013) stated in the preface that he attempted to cover ontogeny throughout the textbook. Although the overall coverage of ontogeny was the highest in his textbook at 12% compared to the rest of the textbooks, two of the chapters did not at all describe ontogeny. Whereas, Breed & Moore (2012) covered ontogeny, to some extent, in each chapter, their overall coverage was 7%. Alcock (2013) and Drickamer et al. (2002) each had three chapters of their textbooks not cover ontogeny.

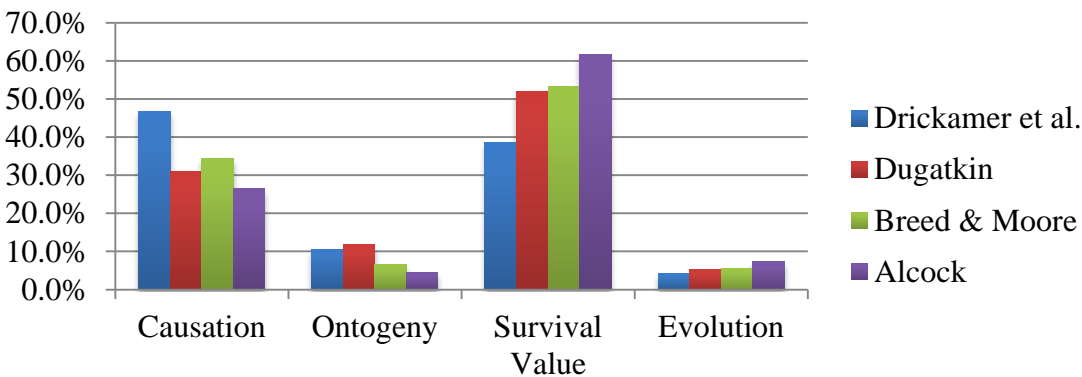


Figure 1: Percentage of textbook coverage of Tinbergen's four questions.

Although evolution was often described as the framework for a textbook, such as Alcock's (2013) *An Evolutionary Approach*, Tinbergen's evolution was rarely discussed. In these cases, the term "evolution" likely referred to both Tinbergen's evolution and survival value (survival value also encompasses natural selection). In terms of Tinbergen's evolution, every textbook rarely explained the evolution of behaviour, with evolution being completely neglected in some chapters. For instance, in Drickamer's et al. (2002) textbook evolution was not covered in five of the 19 chapters, Dugatkin's (2013) textbook did not cover evolution in two of 17 chapters, and Breed and Moore (2012) did not cover evolution in one of 15 chapters. On the other hand, Alcock (2013) covered evolution, to some extent, in every chapter of his textbook. All in all, in regards to Tinbergen's questions, none of the textbooks utilized an integrated approach.

Journal Articles. All four of Tinbergen's questions were answered in the primary literature for 2013 in the journals *Animal Behaviour* ($N = 306$), *Behavioral Ecology* ($N = 163$), *Behavioral Ecology and Sociobiology* ($N = 185$), *Behaviour* ($N = 81$), and *Ethology* ($N = 114$; Figure 1). Most of the literature answered questions on causation (44% of the literature; individual journals ranged from 34 to 48%) and survival value (43% of the literature; range = 40-50%). Ten percent of the literature (range = 7-12%) answered ontogeny questions and 3% (range = 2-5%) of the literature answered evolution questions.

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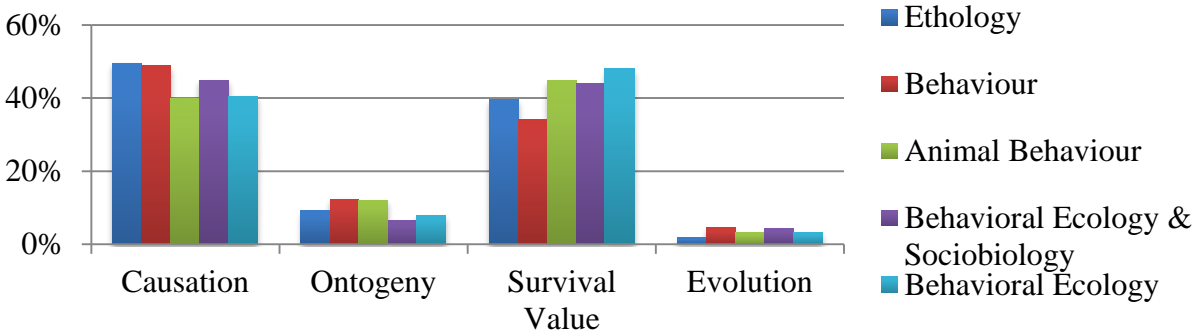


Figure 2: Distribution for the goal of the study per journal.

When the broader context was assessed, more of the literature described survival value (49%; range = 41-52%) than Tinbergen's other questions (Figure 2). Compared to the goal of the study, the percentage of the literature discussing causation was reduced to 36% (range = 35-42%). Evolution increased to 6% (range = 5-7%) and ontogeny dropped slightly to 9% (range = 7-11%).

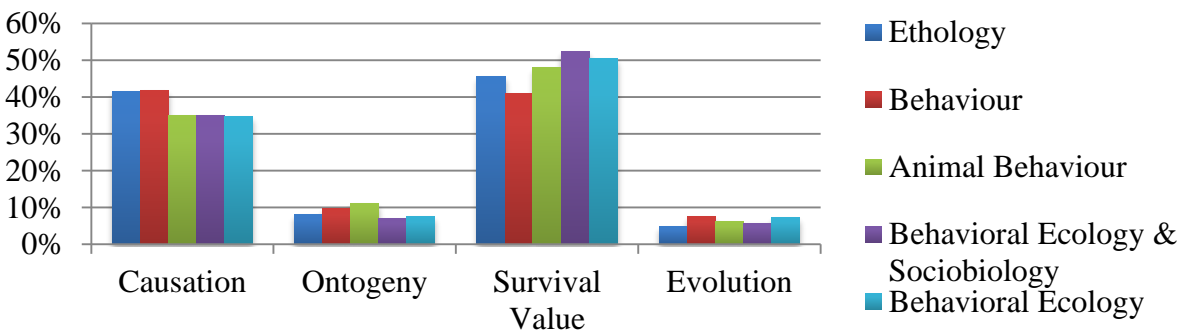


Figure 3: Distribution for the broader context per journal.

Conclusions/Contribution

In conclusion, we discovered that over 80% of the textbook text and over 75% of the primary literature covered two of Tinbergen's questions: causation and survival value. Therefore, the conceptual framework of animal behaviour is not being used as intended. On the other hand, the primary literature aligns with the textbook framework. Although this finding may mean that the framework of animal behaviour should be re-assessed, animal behaviour scientists are still stressing the importance of Tinbergen's integrated framework (e.g., Laland et al., 2013).

The lack of ontogeny and evolution studies could be due to these studies not being completed as frequently and/or being published in other journals. Ontogeny studies often require following individuals throughout their lifetime in order to determine when behaviours develop. This is especially difficult to do for wild animals. Also, as suggested by Price et al. (2011), evolution studies are often limited to available evolutionary trees and current behaviour data from several closely-related species. If the evolutionary tree and behaviour data are not available, then the study is nearly impossible. Moreover, since these types of studies are rare, when they do occur, they are likely being published in highly competitive, broad biology journals. These possible reasons for the lack of ontogeny and evolution articles require further research.

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Overall, due to the alignment between textbooks and primary literature, textbooks are preparing future biologists for the currently used framework. However, since the established/integrated framework is not currently used, animal behaviour textbook authors/editors should incorporate more ontogeny and evolution in books and animal behaviour instructors should teach the established framework so that the next generation of scientists contains more biologists that study ontogeny and evolution of behaviour. Literature outside of mainstream behaviour journals will likely be needed.

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