TEXTBOOK REVIEW
A Review of *Developmental Neurobiology* by Lynne M. Bianchi (in the Context of One Instructor's Evolving Relationship with Scientific Textbooks)

Barbara Lom
Biology Department & Neuroscience Program, Davidson College, Davidson, NC.

I must confess that I had all but given up on scientific textbooks. In my nearly two decades of teaching undergraduate developmental biology and neuroscience I have benefitted tremendously from the labor and expertise of numerous textbook authors; I have used their work to inform the structure and sequence of my courses, to deliver examples beyond my scientific scope, and to provide illustrations for class slides. In recent years, I have reluctantly come to realize that most of my students do not find textbooks appealing or accessible sources of information for their learning. I attained this unexpected realization by flipping and fusing my developmental biology lab course several years ago (Bergmann & Sams, 2012; Round & Lom, 2015). With well-prepared students eagerly engaging in class activities and performing well, I viewed the transformation as a big win. Yet, assessment revealed my students strongly preferred watching my "flips" over readings in excellent textbooks authored by leading scientists, which felt like a loss. I thought voices beyond mine were necessary and important. Plus, I hoped that students would get caught by unexpectedly interesting topics or images when thumbing through textbook pages, distractions and surprises that I particularly welcome in my own learning and reading. My informal inquiries revealed my students strongly preferred watching videos (even my clunky and simple narrated slides) over reading short articles over reading textbooks. They regarded textbooks as expensive, bulky, inefficient, outdated, and/or inconvenient, preferring precisely tailored class preparation. Moreover, with a convenient electronic device in hand to look up any information contained within a textbook, the idea of buying an expensive and heavy book was impractical. Even when I placed textbooks on reserve in multiple campus locations and encouraged the use of mildly older and much less expensive previous editions, my students continued to skip textbook readings. I hypothesized that students just did not realize the utility of a good textbook, so I created what I thought was a clever assignment requiring them to compare how topics were presented in multiple textbooks. My hypothesis was dead wrong; this assignment produced lamentably little change in student regard for textbooks. Finally, when an exceptionally enthusiastic and talented student candidly shared eye rolling disappointment that our neuroscience program awarded scientific books (e.g., Ramon y Cajal, 2004; Kandel et al., 2012; Squire et al., 2012), as recognition of our graduating seniors I could no longer ignore that my relationship with textbooks fundamentally differs from that of my students. As I was learning to accept student frustrations with textbooks, I was reading and hearing more from colleagues about open educational resources (OERs) as sustainable, active, and accessible textbook alternatives. Consequently, I threw in the towel and taught my courses last year without requiring any books (though I continued to suggest textbook readings as supplements to my flipped lecture; the textbooks I provided in the lab did not appear to be consulted).

Encouragingly, Lynne Bianchi's new *Developmental Neurobiology* textbook (Bianchi, 2018) is making me rethink my desertion of textbooks. Moreover, her new book is stimulating me to consider reviving my upper-level developmental neurobiology course, which I stopped teaching about a decade ago in large part because I never quite found a textbook that worked well in my hands. Bianchi's *Developmental Neurobiology* is a refreshingly powerful new textbook in this important subdiscipline of neuroscience because it is so obviously designed with advanced undergraduate readers in mind, and reminds me in important ways of one of the last books on my shelf with which I would part.

As a graduate student in the 1990s I fell in love with developmental neurobiology by reading every word of *Principles of Neural Development* by Purves & Lichtman (1985). Though I did not appreciate it at the time, this textbook was unique in its clarity, in its words and simple black and white visuals as well as for its understated but captivating revelations of the mysteries of how the nervous system builds itself. Leading neuroscientists Dale Purves and Jeff Lichtman skillfully told compelling and informative stories with simple words and images. I saw their textbook at handy reach on the shelves of nearly all my mentors and many of us fully expected a second edition as the field of developmental neurobiology expanded rapidly. Powerful new experimental approaches, for example, revealed the molecular mechanisms of topographic axon guidance responsible for Sperry's classic eye rotation experiments in frogs. Such stories are inherently interesting to those of us who study developmental neurobiology for a living, but even for students with far less inherent interest in the topic these are rich opportunities for teaching the experimental foundation of scientific knowledge and how it is advanced.

In the early 2000s, without any update to the classic Purves & Lichtman (1985) text, several talented scientists authored much-needed, new developmental neuroscience textbooks (Brown et al., 2002; Rao & Jacobson, 2005; Stiles, 2008; Sanes et al., 2011; Fahrbach, 2013). Each textbook unquestionably provided critical scientific updates and added valuable new voices and perspectives to the ways developmental neurobiology was chronicled. Although the science has advanced dramatically since 1985, the tables of contents for these (and subsequent) developmental neurobiology textbooks remained very

similar. Most followed a logical sequence beginning by discussing early developmental events (neural induction, axis formation, regionalization, etc.) then progressing to neurogenesis, migration, differentiation, and synaptogenesis, and ending with examples of later remodeling and reorganization events. Even with multiple textbook options that provided very appropriate and updated content, I was unable to find a textbook that fully clicked for my undergraduates. Often the writing was pitched just a bit too high for even my most advanced students who might not be able to connect the experimental and technical considerations without a bit of assistance. In several textbooks, the illustrations were too minimal in number and/or too similar to the journal articles from which they came rather than thoughtfully constructed as textbook illustrations providing methods context to help undergraduates understand. Only some of these textbooks provided instructor supplements such as electronic figures. I ultimately chose to teach from early editions of Sanes et al. (2011). Though this textbook has many strengths and improved with subsequent editions, students consistently commented that the textbook was dry and less student-oriented than many of their other science texts. They wanted key terms bolded, easy access to definitions, review materials such as questions and summaries, interesting sidelights, and abundant full color figures. In my final iteration of my course Wiring the Brain, I navigated fair use policies to curate a collection of passages from a wide variety of these developmental neurobiology textbooks, as well as from comprehensive advanced neuroscience textbooks (Kandel et al., 2012; Squire et al., 2012) and undergraduate developmental biology texts (Slack, 2012, Wolpert et al., 2015; Gilbert & Baressi 2016). Again, students learned and did well in my course, yet a critical mass commented that the inconsistent voices and formats created by using multiple books, authors, and formats made their heads spin and they were frustrated that our library's electronic reserves provided only black and white figures that lost important information by photocopying. I wished out loud many times that new authors would be inspired by the example set by Purves & Lichtman (1985) to write an up-to-date, clear, compelling, and accessible textbook from which smart and motivated undergraduates could learn.

Bianchi's text has accepted this challenge with skill; its writing and illustrations convey the experimental foundations and excitement of understanding how the brain forms. *Developmental Neurobiology* is very thoughtfully and specifically designed for an advanced undergraduate (or graduate) course in developmental neuroscience. It knows its audience and provides updated content.

Bianchi had me at the first line of the preface, "No one goes into science because they love to memorize facts; they go into science because they love the process of discovery and problem solving." This point exemplifies the author's success in creating a textbook for undergraduates that emphasizes the nature of unknowns in classic and contemporary scientific inquiry and the process of experimentation. The textbook acknowledges our continually evolving understanding of how the nervous system forms and functions, what is currently known and unknown. It introduces many, many important genes, molecules, cells, techniques, and model systems that are critical to understanding how the brain develops, but these specific details are presented as works in progress revealed through the work and intellect of scientists rather than lists of facts to be memorized. Throughout, the book's tone recognizes undergraduate readers as smart and capable of understanding sophisticated contemporary science without dumbing down the terms, but by providing context and methods that help the reader make new connections.

In addition to clear and captivating writing, any good contemporary scientific textbook must include strong illustrations. The artwork is one of the most important features on which I had previously made my textbook selections. Thus, a substantial part of my delight in this textbook arises from its frequent and colorful figures. Although my students may not admire textbooks as I do, we do agree that a good textbook has both a rich narrative and rich images that cooperate to enhance understanding. As someone who cannot have too many pictures in a science text, it is not surprising that I found multiple places where I hoped for additional explanatory figures, but could never call this book's figures underdeveloped. Throughout, readers will find at least one colorful figure per page and frequent subheadings within the text, fully avoiding uninviting pages of undifferentiated text (what my students label TLDR for "too long, didn't read"). The figures in *Developmental Neurobiology* often illustrate similar important points made by figures in other developmental neuroscience textbooks, but in Bianchi's text the figures are distinguished by their abundance, color, style, consistency, and composition. *In vitro* experiments, for example, are often illustrated within a petri dish, a detail not necessary for an expert, but important for young scientists learning to distinguish advantages and disadvantages of *in vivo* versus *in vitro* approaches. The figures are predominantly illustrations, though frequently and appropriately enough accompanied by images from the research literature to help students understand from where summary diagrams are created. Readers do get to see what cells, tissues, and brains looked like to the researchers creating new knowledge. Helpfully, images from the literature are often curated with labels or explanations to orient the audience.

Developmental Neurobiology's content is a very appropriate introduction to the major topics in the field, skillfully providing enough but not too much depth. It does not intend to be an encyclopedic tome, but it extends well beyond the typical chapter or two devoted to CNS development in traditional undergraduate neuroscience or developmental biology textbooks (e.g., Bear et al., 2015; Gilbert & Baressi 2016; Purves et al., 2017; Kalat, 2018). Each of Bianchi's ten chapters includes a short summary and suggests further readings (a few dozen review articles and primary research papers). Thus, this textbook on its own provides sufficient foundation for a full semester-long undergraduate course. More likely, Bianchi's textbook will serve as a course foundation and anchor, allowing

instructors to supplement throughout with research literature they and/or their students select.

The textbook's writing is efficient and clear, avoiding jargon whenever possible but not avoiding challenging topics or language. The pitch is appropriately aimed for readers who arrive with an introductory foundation in basic biology or neuroscience who, however, are not experts. This book looks and feels more like a textbook than many of the texts published after Purves & Lichtman (1985) because it includes features such as highlighted key terms, a glossary, and boxed topics on selected techniques and scientists. Interestingly, the first box highlights Roger Sperry as an undergraduate who majored in English and captained the basketball team at Oberlin College (where Bianchi teaches) before going on to be a Nobel laureate. This important opening immediately acknowledges students and their varied trajectories commenting, "none of the scientists whose work is featured throughout this book had any idea as undergraduate students where their careers would take them." At other points in the book Bianchi notes contributions by her own students. These moves are small but powerful indicators that invite undergraduate readers to see themselves as capable and contributing members of the scientific community.

It is also important to note that *Developmental Neurobiology* reduces many of the logistical hindrances my students described regarding textbooks. For readers who prefer electronic books, *Developmental Neurobiology* is available as an eTextbook that can be used on a variety of platforms and devices, and allows students to click on words to look up definitions, make annotations on the pages, and create flashcards for studying. I admit that I only browsed the eTextbook's free sample pages on my color tablet, but found it to be readily navigable with layout and pagination identical to the hard copy. Notably, this paperback textbook also overcomes hindrances of "doorstop" scientific textbooks. As a 345-page softcover that is just half an inch thick and a bit over over 1.5 pounds, this efficient size will not burst any student's backpack or be a handful for an instructor to carry to class. The large (roughly 8.5 x 11 inch) softcover format also lays open on its own with ample margin room for annotations. Given that some undergraduates can be reluctant or unable to enroll in courses with expensive material costs, it is also important to mention this textbook's price is reasonable, with new copies currently selling at $61 (softcover) and $37 (eTextbook) on Amazon, well below the $99 list price. Finally, supplements for instructors are minimal, those seeking a website or test bank will be disappointed, though I was very pleased that electronic figures (PowerPoint, JPG) are available by emailing the publisher (an easily overlooked note in the preface).

In summary, with *Developmental Neurobiology*, Lynne Bianchi skillfully shares the wonder and mysteries of how the nervous system arises for an undergraduate audience. It is a thoughtful textbook that provides a strong resource to our community and our students, joining two other recent textbooks on this important topic (Breedlove, 2017; Price et al., 2017), creating the most crowded field of choices for a developmental neurobiology textbook that I have had the fortune to experience in my career. I expect Bianchi's first edition will serve students and instructors very well. I look forward to seeing it succeed by informing and inspiring future neuroscientists to understand the beauty and importance of how cells arise, assemble, communicate, and modify to build a functional central nervous system in both health and disease.

REFERENCES

Bear MF, Connors BW, Paradiso MA (2015) Neuroscience: Exploring the Brain. 4th edition. Philadelphia, PA: Wolters Kluwer.

Bergman J, Sams A (2012) Flip Your Classroom: Reach Every Student in Every Class Everyday. International Society for Technology in Education.

Bianchi LM (2018) Developmental Neurobiology. New York, NY: Garland Science.

Breedlove SM (2017) Foundations of Neural Development. Sunderland, MA: Sinauer.

Brown M, Keynes R, Lumsden A (2002) The Developing Brain. New York, NY: Oxford University Press.

Fahrbach SE (2013) Developmental Neuroscience: A Concise Introduction. Princeton, NJ: Princeton University Press.

Gilbert SF, Baressi MJF (2016) Developmental Biology, 11th edition. Sunderland, MA: Sinauer.

Kalat JW (2018) Biological Psychology.13th edition. Boston, MA: Cengage.

Kandel ER, Schwartz JH, Jessell TM, Sigelbaum SA, Hudspeth AJ (2012) Principles of Neural Science, 5th edition. New York, NY: McGraw-Hill.

Price DJ, Jarman AP, Mason JO, Kind PC (2017) Building Brains: An Introduction to Neural Development, 2nd edition. Hoboken, NJ: Wiley-Blackwell.

Purves D, Lichtman JW (1985) Principles of Neural Development. Sunderland, MA: Sinauer.

Purves D, Augustine GJ, Fitzpatrick D, Hall WC, LaMantia AS, Mooney RD, Platt ML, White LE (2017) Neuroscience. 6th edition. Sunderland, MA: Sinauer.

Ramon y Cajal (2004) Advice for a Young Investigator. Cambridge, MA: MIT Press.

Rao MS, Jacobson M (2005) Developmental Neurobiology, 4th edition. New York, NY: Kluwer Academic/Plenum Publishers.

Round J, Lom B (2015) *In situ* teaching: Fusing labs and lectures in undergraduate science courses to enhance immersion in scientific research. J Undergrad Neurosci Educ 13: A206-214.

Sanes DH, Reh TA, Harris WA (2011) Development of the Nervous System, 3rd edition. Cambridge, MA: Academic Press.

Slack JMW (2012) Essential Developmental Biology, 3rd edition. Hoboken, NJ: Wiley-Blackwell.

Squire LR, Berg D, Bloom FE, du Lac S, Ghosh A, Spitzer NC (2012) Fundamental Neuroscience, 4th edition. Cambridge, MA: Academic Press.

Stiles J (2008) The Fundamentals of Brain Development: Integrating Nature and Nurture. Cambridge, MA: Harvard University Press.

Wolpert L, Tickle C, Martinez Arias A (2015) Principles of Development, 5th edition. New York, NY: Oxford University Press.

Received July, 11, 2018; accepted July 11, 2018.

Address correspondence to: Dr. Barbara Lom, Davidson College Biology, Box 7118, Davidson, NC 28035-7118. Email: balom@davidson.edu