

Problem/Discussion Set for “The Process of Model Building”

1. **Modeling Strategies.** How do the authors of each paper justify making a model of the middle ear? Describe the overall approaches. How are their modeling strategies similar and/or different? Summarize the modeling “philosophies” that the authors convey in each paper.
2. **Model Testing.** Zwislocki, Kringlebotn, and Pascal et al. all relate their middle ear models to experimental findings. In each paper, what data were used to constrain model parameters? What data were used to test the model? Do the authors distinguish between “constraining parameters” and “testing the model”? Is it important to make this distinction?
3. **Model Success.** Each paper makes claims about the validity of their representation of the middle ear. What are these claims, and how well do the authors support them? How do the various authors determine and justify the validity of their parameter values?
4. **Averaging.** As Zwislocki and Kringlebotn illustrate, it is common practice to compare middle-ear models to data representing an “average” middle ear. What are the pros and cons of this practice? If averaging is performed, how should it be done? For example, is it better to take arithmetic or geometric means?
5. **Model Topology.** Each of the three middle-ear models has the same overall network topology (i.e., the sequence and interconnection of major functional units or blocks). What determines this topology and how do the authors justify it?
6. **Nonlinearity.** Describe the nonlinearities introduced by Pascal et al. What assumptions are made? Are they physiologically reasonable? Why or why not?
7. **Modeling the Eardrum.** How do the various models for the eardrum differ? Imagine that you decided to test the various models of eardrum transduction and/or propose a new one. How would you go about it?
8. **Cochlear Compressibility.** All of the middle-ear models implicitly assume that the cochlear fluids are incompressible. Is this assumption manifest in their models? How might you modify the models to allow for a non-zero cochlear compressibility? Are there any circumstances when allowing for a non-zero compressibility might be important?
9. **Reciprocity and Reverse Transmission.** The middle ear is believed to be a reciprocal system. What does this mean? Evoked otoacoustic emissions, which involve both forward and reverse transmission by the middle ear, provide a possible application of reciprocity. One perhaps relevant measure of forward transmission is the pressure transfer function $T_{\text{forward}} \equiv P_{\text{ow}}/P_{\text{ec}}$, where P_{ow} is the pressure inside the oval window and P_{ec} is the ear-canal pressure. Measurements of $|T_{\text{forward}}|$ in human cadavers indicate that it is about 15–20 dB re 1 near 1 kHz. Can you use this information to find the pressure transfer function in the reverse direction, T_{reverse} ?
10. **Better Models.** How might you go about making a better middle-ear model? Outline possible strategies, based on several different definitions of “better.” What measurements would be needed to determine the input and output characteristics of the middle ear?