



Mathematical Logic: Response to Jay Rahn

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[1] The title of Jay Rahn's article covers a lot of terminological ground: "From Similarity to Distance; From Simplicity to Complexity; From Pitches to Intervals; From Description to Causal Explanation." Ultimately, however, it seems to boil down to an exercise in the expressiveness of first-order logic for articulating a theory of pitch. In paragraph 2.3 he tips his hand by acknowledging that all that has gone before (and much of what is to follow) is based on the implicit promise that "the world is, in fact, truly characterized according to first-order logic". Since what is actually at stake here is the ability to express some fundamental properties of auditory perception, I think that this promise should not be allowed to slip by without comment.

[2] The issue is not whether the world is "truly characterized according to first-order logic." Those of us who are interested in the world must draw upon ways to try to describe it. This is as true when we engage in dialog and try to argue out our descriptions and the inferences we can draw from them as when we think about these matters in solitude and basically try to describe the world to ourselves. First-order logic is one way to approach this descriptive task; but it is not the only way. Furthermore, it is unclear that there is any standard of rating which would allow us to conclude that it is the best way (or that any other way is decisively better). All approaches to description vary in effectiveness according to the nature of the situation being described.

[3] So what situation are we trying to describe here? I think there is a potential confusion lurking here because *physical* stimuli and *perceived* stimuli are not the same phenomena. Ultimately, it seems as if Rahn wants to tackle describing the properties of perceived stimuli; but it also seems as if he keeps falling back on properties of physical stimuli.

[4] As a consequence, much of what we know about auditory perception tends to ride along in the back seat. Nevertheless, in paragraph 2.1, with the discussion of Shepard tones, it looks as if perception might even get to take the wheel; but Rahn backs away with the observation that the "illusion" of Shepard tones "depends on temporal succession." This is certainly true if you are only interested in illusions of infinite ascent or descent; but Diana Deutsch has demonstrated that there are more to Shepard tones than this simple illusion. She demonstrated this during a special "cognitive" session at the Oakland SMT meeting in 1990, where all of us present got to serve as subjects for one of her more classical experiments: If you play the interval of a tritone in Shepard tones, it turns out that just about any group of listeners will disagree reasonably evenly as to which of the two pitches sound higher. Thus, Rahn's AH predicate, while it makes reasonable sense when applied to physical

stimuli, is not necessarily (and certainly not always) a well-formed descriptor of how pitch is perceived.

[5] The key problem with Rahn's approach is that it overlooks two fundamental properties of human perception (which includes auditory perception). One is that it is *context-dependent*, and the other is that it is *subjective*. By virtue of either (or both) of these properties, two physically identical stimuli may be perceived as different. Within Rahn's descriptive formalism, this would mean that, at the perceptual level, one could have a physical thing be higher than itself, thus violating one of the most important properties underlying the predicates of his model.

[6] There are some other premises which also deserve some questioning. One is in paragraph 1.9: "Behaviorally, however, it is generally advantageous for a listener that hears pitchwise to hear with optimum pitch acuity. . . ." Actually, there seem to be behavioral advantages to categorical perception. This is where (as is discussed in Stephen Handel's *Listening* book) our acuity seems to be deliberately "blunted," enabling us to categorize a rather broad range of frequencies as all corresponding to a common pitch. (This seems behaviorally advantageous, since none of us, as performers, produce pitches with the frequency acuity of machines; so we would not want to try to perceive each other's performances as being so machine-like.)

[7] Bringing the psychology of auditory perception into the picture also throws a new light on the challenges of nominalism. Much of what Rahn discusses hinges on being able to come up with sufficiently accurate descriptors for quantitative differences. However, during a discussion session at the recent International Conference for Music Perception and Cognition, I raised what I called the "One-Two-Three-Infinity" Hypothesis about the perception of quantitative differences. (The title is a debt to my youthful enjoyment of the first anecdote related by George Gamow in his book of the same name.) The point is that, along some given metric, we may be able to recognize perceptual differences of one, two, or even three units; but, after some difference, we only recognize the distance as being "a lot" and can no longer resolve it with the same quantitative accuracy. I do not know of any psychological experiments which have been designed to test this hypothesis. However, given the different ways in which we seem inclined to work with difference metrics, particularly when comparing pitches or pitch classes, I think it is about time that some of those experiments be designed and run.

[8] In spite of the rather negative tone of this response, I am as concerned as Rahn is with the challenges of nominalism. While his punch line casts a net over two millennia of music history, I think that there *is* a real challenge in trying to identify just what is worth saying for a theory of pitch. However, I question his use of the word "else" in paragraph 5.1 because, as I have tried to argue above, Rahn's AH predicate just does not cut the mustard. To end on a more positive note, I would argue that anything worth saying for a theory of pitch should be grounded in a theory of perceptual categorization, such as the one I suggested in my "Neuronal" paper in *In Theory Only* (Smoliar 1992). Establishing which of those statements can be so grounded will again require psychological experiments which have not even been designed, let alone performed. However, any theory of pitch must be a theory of how pitches are perceived, rather than how they are produced; and I believe that a better understanding of perceptual categorization is our best hope for such a theoretical approach to pitch.

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