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From Similarity to Distance; From Simplicity to Complexity; From Pitches to Intervals; From Description to Causal Explanation

Jay Rahn

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ABSTRACT: Words and phrases specifying similarity and distance abound in musical discourse. This essay explores such pitch-predicates as "matches", "is in the vicinity of", and "is closer to . . . than to". Sought here are ways in which pitch and pitch-interval predicates might be inter-connected logically. Within a nominalist framework, an orderly progression from pitch- to pitch-interval-predicates can be proven and interpreted in terms of simplicity. Also indicated are connections between the present formulation and issues of (i) dimension- ality and explanation in psychoacoustics, Gestalt psychology, and behaviorism, and (ii) nominalism and the "numerological fallacy" in music theory.

KEY TO LOGIC SYMBOLS:

(x)(....) = for any thing, x, ...
.... ↔ .... = ... if and only if ....; .... iff ....
.... v .... = ... and/or ....; (vel; inclusive or)
.... = both .... and ....
-.... = not ....; it is not the case that ....
.... → .... = if ...., then ....
(:Ex)(....) = there is at least one thing, x, such that ....
...+... = ...plus...; all the parts of individual..., as well as all the parts of individual... (including any parts common to both ... and ...); the sum of individuals ... and ... (which is, itself, an individual)

[0] Introduction

[0.0] Words and phrases specifying similarity and distance abound in musical discourse. For example: (i) two notes or tones (or even passages or pieces) are often characterized as matching, being the same, like each other, or similar in pitch (or pitch-structure), and (ii) pairs of sounds are frequently described as differing, contrasting, or being remote, far apart, or distant—all these, in varying degrees or amounts (e.g., somewhat, extremely, etc.). Between twosomes that are precisely the same in some respect, and those which are exceedingly distant, one recognizes intermediate cases. One asserts, for instance, that two sound-events, a and b, are (i') next, or adjacent, to each other (i.e., neighbours, in some sense), or (i") closer, or nearer, to one another (i.e., than a and/or b are/is to yet another sound-event, c).

[0.1] "Common sense" acknowledges as orderly, or linear, a progression from sameness (i), through adjacency (i'), to relative proximity (i"), and onward to remoteness (ii). Things that do not match, differ. Of those that differ, the closest are those that are adjacent. And among non-adjacent things, one can distinguish degrees of distance. Despite the continuity of this progression, common sense also acknowledges that sameness is "qualitative," whereas distance is "quantitative." Nonetheless, one might contend that things which are relatively similar are also relatively close in some "dimension" (e.g., pitch), and that, within a single dimension, far-apart things are very dissimilar.

[0.2] Particular traditions of musical thought (e.g., in psychoacoustics) comprehend similarity and distance as polar opposites along single continua (e.g., scaled or gradated in difference-limens or mels: cf. Stevens and Davis 1983, 76–98). By contrast, other lines of musical inquiry (e.g., inspired by Gestalt psychology: cf. Koehler 1947, 84–85 and 117–18) dichotomize in this regard, understanding similarity (or sameness) and proximity (or distance) as distinct principles of perceptual organization or grouping.

[0.3] The present study probes the notion that, in such a musical dimension as pitch, there might be continuity between similarity and distance. The investigative strategy undertaken here is to pursue, until an impasse is reached (if at all), the possibility that there might be an unbroken progression from similarity to distance. In the development that follows, I try to clarify ways in which one might distinguish (or not) pitches from intervals. Attempted is the formulation of a common groundwork for dealing with similarity and distance in pitch. As far as possible, pitch- and interval-predicates are defined in terms of a single, maximally economical, basic, primitive predicate, so that (i) necessary, logical connections between predicates can be proven, or (but only if need be) postulated—albeit, one seeks, in a maximally coherent manner, and (ii) stages or gradations between similarity and distance (e.g., comprising next-to and closer-to relations) can be identified clearly. A further tactic adopted in this account construes predicates of similarity and distance in terms of simplicity and complexity (i.e., "structure") and emphasizes, in this connection, relations between parts and wholes and between statements that can be true of a single thing and statements that only can be true of more than one thing.

[0.4] The formulation of pitch that follows does not involve numerical modeling (i.e., as such). In this way, an effort is made here to prevent, or at least forestall, systematically and fundamentally, lapses in discourse that might produce instances of the "numerological fallacy." As John Rahn notes at the outset of his exposition of the "integer model of pitch" (1980, 19):

> . . . all sorts of things can be proven true of integers—see any book on number theory. It does *not* follow that, because we are using integers to name pitches (or grapes, [etc.]), all those things that are true of integers are going to be true of pitches (or grapes, [etc.]). We must carefully determine the limits of similarity between integers (with their structure) and pitches (with their possible structures). To do otherwise would be to fall into the *numerological fallacy*.

[0.5] To this end, instead of being framed in terms of numbers, the following formulation is cast in terms of things that are neither numbers nor sets; that is, what follows is cast in a nominalist outlook (for which, see Goodman 1966) and accordingly framed in terms of "individuals," as well as predicates that specify relations between, or among, such individuals. In this sense, general music-theoretical traditions that form an immediate background to the present study are Aristoxenian rather than Pythagorean, nominalist rather than platonist.

[0.6] An idea that guides the present exposition is that two things might constitute a relatively simple whole, and, correspondingly, be relatively similar, or close, to one another, to the extent that they are described in terms that can be used to describe a single thing. Initial stages of the subsequent account involve relations of matching, adjacency, and proximity, and explore a sense in which these correspond, respectively, to situations of increasing complexity.

[1] Matching

[1.0] If two things match in pitch, they form a simpler pair than if, all other aspects being the same, they had differed in pitch. The criterion, or benchmark, is a single, inherently pitched thing, which (i) cannot differ, in pitch, or pitch-wise, from itself, and (ii) if inherently pitched, necessarily is the same, in pitch, as itself. Concerning (ii), one can define an inherently pitched thing as follows: [(1)]

DEFINITION: (x)(IPx ↔ xPRx)
For any thing, x, x is inherently pitched if and only if x is pitch-related to x (i.e., to itself).

[1.1] The two-place predicate "is pitch-related to" can be defined in the following way:

DEFINITION: (x)(y)(xPRy ↔ xAHy v yAHx)
For any thing, x, and any thing, y, x is pitch-related to y if and only if x is at least as high as y and/or y is at least as high as x (cf. Rahn 1992, 164–65).

[1.2] The predicate "matches, in pitch," can be defined as follows:

DEFINITION: (x)(y)(xMPy ↔ xAHy . yAHx)
For any thing, x, and any thing, y, x matches, in pitch, y if and only if x is at least as high as y and y is at least as high as x (cf. Rahn 1992, 167).

[1.3] From these definitions, one can prove the following theorem:

THEOREM: (x)(IPx ↔ xMPx)

Proof: (x)(IPx ↔ xPRx)
(x)(xPRx ↔ xAHx v xAHx)
(x)(xAHx v xAHx ↔ -(-xAHx . -xAHx))
(x)(-(-xAHx . -xAHx) ↔ -(-xAHx))
(x)(-(-xAHx) ↔ xAHx)
(x)(xAHx ↔ xAHx . xAHx)
(x)(xAHx . xAHx ↔ xMPx)—i.e., MP is reflexive for any inherently pitched thing.

[1.4] The other portion (i) of the criterion arises directly from the following definition for pitch-difference:

DEFINITION: (x)(y)(xDPy ↔ xPRy . -xMPy) For any things, x and y, x differs, in pitch, from y if and only if x is pitch-related to y and x does not match, in pitch, y (cf. ibid., 172).

[1.5] As a relation, pitch-matching is proven (above) to be reflexive for any inherently pitched thing whatever. As well, pitch-matching has been proven, in an earlier study, to be symmetric for any pair of things whatever (i.e., pitched or non-pitched, inherently so, or not: ibid., 168):

THEOREM: (x)(y)(xMPy ↔ yMPx)

[1.6] Additionally, it can be proven that if any two things, x and y, match, in pitch, then each is pitch-related to the other even if "they" are precisely the same thing (i.e., even if x=y):

THEOREM: (x)(y)(xMPy → xPRy . yPRx)

[1.7] If, amidst the "booming, buzzing confusion" of Nature, one acts in an AH-manner, that is, if one "hears" certain things "as" being at least as high as others (or even as themselves), an immediate consequence of the energy expended in such an act of hearing is that one's world divides into things that are entirely unpitched and things that are inherently, and/or non-inherently, pitched. The single inherently pitched things are heard as matching themselves in pitch. Such singletons constitute a template, or model, for pitch-simplicity, or pitch-singleness; pitch-matching necessarily holds within inherently pitched things (i.e., "severally", e.g., within each of the two inherently pitched things of a pair) but might not hold between or among them (i.e., "jointly", e.g., between the two inherently pitched things of such a pair). Two inherently pitched things that match pitchwise constitute a simpler pair than two that do not match in pitch, at least with respect to pitch, all other factors being equal.

[1.8] "A pitch" can be regarded merely as a sum of all, and only, certain things that match each other in pitch (cf. Rahn 1992, 165 on "pitch-identity wholes" and Goodman 1966 on sums of individuals, which, as sums, are, themselves, individuals). Unless there were at least one instance of non-matching, or difference, in pitch, between two of them, then all pitched things would be heard as matching in pitch. In such a situation of universal non-differentiation in pitch (i.e., obtaining between any and all pitched things), all pitched things would be heard as "parts" of "a" single "pitch". That is, only "one pitch" would be heard and would comprise all, and only, the pitched things.

[1.9] Behaviorally, however, it is generally advantageous for a listener that hears pitchwise to hear with optimum pitch acuity (e.g., relative to an immediate biological niche), that is, to hear as few things as possible as matching in pitch. To be sure, each inherently pitched thing necessarily matches itself in pitch. But in such an instance, pitch-matching is just another name for pitched-ness. Pitch-matching relations are not effectively significant, or important, for a listener, unless they hold between non-identical things (i.e., between, for instance, acts of hearing, x and y, where -(x=y)).

[2] Vicinity

[2.0] In the present formulation, every inherently pitched thing is regarded as being "in its own pitch vicinity." As well, all things that match each other in pitch, whether inherently pitched or not, are held to be pitch "neighbors." This general sense of pitch-neighborhood or -vicinity is conveyed as follows:

DEFINITION: (x)(z)(xIPVz ↔ xNMTJHTz v zNMTJHTx)
For any things, x and z, x is in the pitch-vicinity of z if and only if x is no more than just higher than z and/or z is no more than just higher than x.

DEFINITION: (x)(z)(xNMTJHTz ↔ xAHz . -(:Ey)(xHTy . yHTz))
For any things, x and z, x is no more than just higher than z if and only if x is at least as high as z and there is no thing, y, such that x is higher than y and y is higher than z.

DEFINITION: (x)(y)(xHTy ↔ xAHy . -yAHx)
For any things, x and y, x is higher than y if and only if x is at least as high as y and y is not at least as high as x. [(2)]

[2.1] It can be shown that xMPz is a special case of xIPVz only if there is no "intervening" thing, y. Such a situation would arise in an instance of "Shepard's tones" (cf. Shepard 1964), where, arranged in "descending" semitones, the first might be heard as matching the thirteenth, and yet as higher than the twelfth, which would be heard as higher than the thirteenth. Important to emphasize is that the "illusion" of Shepard's tones depends on temporal succession and is not merely a matter of pitch, as might be a (hypothetical) Shepard's "sonority". In the present formulation, matching in a vicinity is linear, not cyclic, and a pitch-vicinity comprises not only pitch-proximity, but concomitant temporal closeness too.

[2.2] If xIPVz and x does not match z pitchwise, then xHTz or zHTx. Such cases are similarly linear, and involve always an HT-relation. Such an HT-relation constitutes a significant articulation in the continuity from matching to distance, for no thing whatever can be higher than itself. In this way, vicinity-relations straddle singleness and multitude.

[2.3] The present sort of distinction, i.e., between matching and vicinity, arises "for free," as it were, once such a predicate as AH is let loose in the world. The differences in definition between matching and vicinity involve, in their respective formulations, merely differences in their patterning of quantifiers, conjunctions, modifiers, individual-variables, and the AH predicate. If one hears in an AH manner, opportunities to make such a distinction can arise (if the world is, in fact, truly characterized according to first-order logic).

[2.4] Defining vicinity relations widens the net of simplicity that can be caught in a formulation. Single inherently pitched things (even single inherently pitched sums of individuals, which are themselves individuals) supply a criterion for asserting the simplicity of pairs of things, whether the things are individuals and/or sums of individuals, and whether the pairs are, pitch-wise, both matching and neighbors, or merely neighbors. The relatively weak, indeterminate specification that pitch-vicinity things (x and z in the definition) need merely be pitch-related (insofar as xAHz and/or zAHx), rather than, say, different in pitch (i.e., by virtue of one being higher than the other), widens the net considerably.

[3] Interiority

[3.0] Concerning the following succession of letters: a b c, one can say, informally, that a is closer to b than (it, i.e., a, is) to c, and conversely, that c is closer to b than to a. As well, informally, b is closer to a than a is to c, b is closer to c than c is to a, b is closer to the sum of a and c (i.e., a+b) than a is to c, and so forth. Abbreviating the first two statements as aCb, and cCb,a, respectively, one can characterize closeness relations in the larger succession: a b c d, as follows: aCb,c; aCb,d; aCc,d; bCc,d; cCb,a; dCb,a; dCc,a; dCc,b; aCb+c,d, and dCb+c,a.

[3.1] A corresponding pitch-predicate, "is, in pitch, at least as close to . . . as to", can be defined as follows:

DEFINITION: $(x)(y)(z)(xPACy,z \leftrightarrow xPOSy,z)$
For any things, x, y, and z, x is, in pitch, at least as close to y as (x is) to z if and only if x is, in pitch, on the opposite side of y from z.

DEFINITION: $(x)(y)(z)(xPOSy,z \leftrightarrow xHSy,z \lor zHSy,x)$
For any things, x, y, and z, x is, in pitch, on the opposite side of y from z if and only if x is on the high side of y from z and/or z is on the high side of y from x.

DEFINITION: $(x)(y)(z)(xHSy,z \leftrightarrow xAHy \,.\, yAHz \,.\, xAHz)$
For any things, x, y, and z, x is on the high side of y from z if and only if x is at least as high as y, y is at least as high as z, and x is at least as high as z.[3]

[3.2] Pitch-closeness and pitch-sidedness of this sort can be formulated in terms of things that comprise, or include, pitchwise, other things (or themselves), as follows:

DEFINITION: $(x)(y)(z)(x+zCPy \leftrightarrow xPOSy,z)$
For any things, x, y, and z, the sum of x and z comprises, pitch-wise, y if and only if x is, in pitch, on the opposite side of y from z.

[3.3] The partially-ordered character of pitch-comprising relations can be provided for in terms of pitch-interiority (or pitch-insideness):

DEFINITION: $(w)(x)(y)(z)(x+yPIw+z \leftrightarrow w+zCPx \,.\, w+zCPy)$
For any things, w, x, y, and z, the sum of x and y is, pitchwise, inside, or interior to, the sum of w and z if and only if the sum of w and z comprises, pitchwise, x, and the sum of w and z comprises, pitchwise, y.

[3.4] As well, one can prove that things which form pitch-, pitch-matching, and pitch-vicinity relations constitute pitch-interiority relations, but not necessarily *vice versa*. For example, within a pitch-interiority framework, possible situations involve xHTy, yHTz, and xHTz, and xHTy, yHTz, and xMPy (the latter corresponding to a moment of "dis-illusion-ment" in hearing Shepard's tones).

[4] Possible Steps Toward Interval Predicates

[4.0] Interiority relations exhaust the farthest reaching possibilities for specifying degrees of pitch-distance within the AH-dimension. Whereas one can acknowledge (i.e., for any w, x, y, and z—see above) that w+z is more inclusive than w+y or x+z, one cannot specify, in the most general way, whether w is more distant from y than x is from z, or w is farther from x than y is from z, or w forms a larger interval with x than x forms with y, etc., except, for example, by (i) specifying that all non-matching vicinity-pairs are equidistant (i.e., taking non-matching vicinity as the "unit" or "degree" of pitch gradation), or (ii) resorting to a predicate other than AH.

[4.1] Plausible predicates to perform such functions include "is at least as large as", "is at least as much larger than . . . as . . . is than", "is at least as much higher than . . . as . . . is than", and "is at least as much larger than its next to largest part, as . . . is than its next to largest part"—cf. Jay Rahn 1994b, where the arguments might be individual-variables (e.g., w, x, y, z, above) or sums of individual-variables, which are themselves individual-variables (e.g., w+x, w+y, . . . , above). Each such predicate can be regarded as introducing a novel "dimension" into a formulation (e.g., a dimension of pitch-interval, pitch-proportion, or pitch-proportionateness—as distinguished from pitch). And each can yield matching, vicinity, and interiority relations in its respective dimension.

[4.2] Alternatively, one could "count" overlapping vicinity-pairs by, for example, (i) defining a special case of pitch-vicinity, namely, discrete pitch neighborhood:

DEFINITION: (x)(y)(xDPNy ↔ xIPVy . xDPy)
For any things, x and y, x is a discrete pitch-neighbor of y if and only if x is in the pitch vicinity of y, and x differs, in pitch, from y, and (ii) applying the label "pairwise twofold" to the sums of such discrete-vicinity pairs as w+x and x+y (i.e., w+x+y) and x+y and y+z (i.e., x+y+z), the label "pairwise three-fold" for the sum of such a pair as w+x, x+y, and y+z (i.e., w+x+y+z), etc. Such a formulation could suffice in certain situations (e.g., where the semitone functioned as the DPN unit, in total-chromatic pieces, or passages). However, much music, if not most, is not totally chromatic. Instead, diatonic and pentatonic works, for example, are generally "gapped" (i.e., relative to the twelve-semitone collection, or aggregate). In order to specify that, for instance, E–F was half as large as F–G, or as much smaller than F–G as G–B♭ was than B♭–D, would require such a postulate as the following:(4)

POSTULATE: (x)(y)(z)(xDPNy . yDPz . zPOSy,x . -yDPNz ↔
(:Ey')(y'POSy,x . zPOSy',y . yDPNy'))

[4.3] Nonetheless, among things that are partially ordered in pitch, one can specify certain degrees of proximity based on discrete-vicinity, or "unit," relations—for example, as follows:

DEFINITION: (x)(y)(z)(x+zJLPy+z ↔ xDPNy . zPOSy,x)
For any things, x, y, and z, the sum of x and y is just (i.e., by one "unit") larger, in pitch, than the sum of y and z if and only if x is a discrete pitch-neighbor of y, and z is, pitchwise, on the opposite side of y from x.

[5] Challenges of Nominalism

[5.0] As Nelson Goodman indicates (1966, 41), "To reconstruct in the language of individuals [i.e., as distinguished from sets and numbers, as such] all of mathematics that is *worth saving* is a formidable task that need not concern us here. It will be enough to consider typical arithmetical statements used in ordinary discourse [my emphasis]." At the conclusion of his subsequent preliminary survey of ways in which mathematical statements can be "de-numerated", and "dis-membered" (my terms—to which one could add "de-generated"), Goodman stresses (1966, 45) that the "effort to carry out a constructive nominalism is still so young that no one can say exactly where the limits of translatability lie. We have seen above that some statements that look hopelessly platonistic yield to nominalistic translation and the full resources available to the nominalist have not by any means been fully exhausted as yet."

[5.1] More recent studies have attempted non-numerical renderings of mathematics on quite a large scale (notably, Field 1980 and Hellman 1989, the former not without controversy). However great their eventual success might be, attempts at modeling music by means of nominalistic formulations, or, alternatively, by means of the mathematics of sets and numbers, should be assessed not only systematically and philosophically, but also by considering seriously what is "worth saving" in accounts of music. Arguably, pitchedness (inherent or not), matching, vicinity, and interiority, none of which presumes an intervallic dimension, i.e., distinct from the AH-dimension, are worth saving. Nonetheless, after more than two millenia of music theory, it is still not entirely clear just what else is worth saving for a theory of pitch—or how it might best be saved.

[6] From Description to Causal Explanation

[6.0] Quite surely, insights of Gestalt psychology into musical structure are worth saving in music theory. However, whereas Gestalt approaches provide valuable descriptions of musical activity, the explanatory status of such accounts is generally questionable (cf. Skinner 1974, 29 and 71–75 on "topography" or mere description, as contrasted with causal explanations of behavior). Nevertheless, the Gestalt principles of similarity and proximity, drawn here into a single account, can be outfitted with causal force by construing as reinforcing the sorts of simplicity considered in the present study (cf. also Rahn 1994a).

[6.1] For example, things (i.e., stimuli) that are heard as matching pitchwise can be considered to constitute the immediate reinforcers of acts (i.e., responses) of hearing things, in general, in an AH-manner. By virtue of being heard as matching in pitch, such stimuli as x and y immediately become a pair of things that have been heard as matching pitchwise. Such a pair is a reinforcing stimulus, or reinforcer, for the relevant acts of "hearing as." Such acts can be designated x' and y', as in the following, behavioral postulate:

POSTULATE: (x)(y)(xHAHy ↔ (:Ex')(:Ey')(x'Hx . y'Hy . x'AHy'))
For any things, x and y, x is heard as being at at least as high as y if and only if there is at least one thing, x', and there is at least one thing, y', such that x' is a hearing of (i.e., an act of hearing, or an auditory response to) x, y' is a hearing of y, and x' is at least as high as y'.

[6.2] The latter postulate distinguishes between stimuli and responses and can be considered to occupy a territory that straddles descriptive music theory and the causal formulations of behaviorism. In this postulate, the HAH- and AH-predicates are morphologically identical. Each merely orders pairs of things; that is, neither involves presumptions, or axioms, of reflexivity, symmetry, etc., and both presume only that the distinction between xy and yx might be significant within its respective (HAH- or AH-) "dimension". Accordingly, one can reason about HAH-things in a manner quite parallel to ways, outlined above, for reasoning about AH-things.

[6.3] The preceding postulate can be replaced and extended in significance by the following:
POSTULATE: (x)(y)(xMPy ↔
(:Ex')(:Ey')(x'SHx . y'SHy . x'HAHy' . y'HAHx' . x'+y'Rx+y))
For any thing, x, and any thing, y, x matches, in pitch, y if and only if there is at least one thing, x', and there is at least one thing, y', such that x' stimulates the hearing of x, y' stimulates the hearing of y, x' is heard as being at least as high as y', y' is heard as being at least as high as x', and the sum of x' and y' reinforces the sum of x and y.

[6.4] Fashioning nominalistically an account of reinforcement presents formidable challenges (cf. Rahn 1993). Among these is distinguishing between earlier and later instances, or portions, of stimuli and responses. That reinforcement often develops in a curvilinear manner can also be problematic. Just as one can eat too much, beyond a certain point one can be satiated by repetition and other kinds of similarity. As boredom sets in, sorts of stimuli that formerly had been reinforcing become aversive. One way of preventing something from becoming "too much of a good thing" involves rendering it less thing-like: less simple, less "singular". Between the extreme possibilities of a world where (i) every inherently pitched thing differed in pitch from every other and (ii) every (inherently or non-inherently) pitched thing matched pitchwise every other (including itself), lies a region in which music has specialized. Moreover, music has specialized in a world where salience is sought and reinforced.

[6.5] Stimuli that are heard as pitchwise matching constitute reinforcers of acts of pitchwise hearing. Stimuli that escape or "e-lude" the net of matching-relation simplicity might be caught by the discrete-vicinity net. Those that elude discrete-vicinity might be trapped by relations of interiority, which can, in turn, vary in their degrees of simplicity. Moreover, interiority-simplicity can been shown to abound generally in the middles of things, i.e., of individual-sums. That the highest degree of proportionateness between things that differ in (e.g., pitch-intervallic) size arguably obtains between a thing and its (precise) half indicates the possibility of coherent continuity in a progression of simplicity reinforcement that might extend beyond AH-relations into the "truly intervallic". And that highest and lowest things stand out, are salient, or "edgy", not only derives from the general paucity of adjacency or interiority relations in which they participate but also renders them "excellent," "privileged," "prime" candidates for "resolution," that is, for being heard, by way of other, simplifying relations, as (proper) parts of relatively simple, reinforcing wholes (e.g., as the soprano-bass "skeleton" of a complex texture, or as the "exo-skeleton" (my term) of a "contour"—on which see Morris 1993).

Jay Rahn
York University (Canada)
Atkinson College
Fine Arts Department
4700 Keele Street

North York, Ontario M3J 1P3
relation@vm1.yorku.ca

Works Cited

Field, Hartry. 1980. *Science without Numbers: A Defence of Nominalism*. Princeton, NJ: Princeton University Press.

Goodman, Nelson. 1966. *The Structure of Appearance*. Indianapolis: Bobbs- Merrill.

———————. 1961. *Science and Simplicity*. Washington, D.C.: Voice of America (repr. in Nelson Goodman. 1972. *Problems and Projects*. Indianapolis: Bobbs-Merrill. 337–46).

Hellman, Geoffrey. 1989. *Mathematics without Numbers: Towards a Modal-Structural Interpretation*. Oxford: Clarendon Press.

Koehler, Wolfgang. 1947. *Gestalt Psychology*. New York: Liveright (repr. New York: New American Library).

Morris, Robert D. 1993. &ldquo:New Directions in the Analysis of Musical Contour." *Music Theory Spectrum* 15, 2: 205–28.

Rahn, Jay. 1994a. "Outline of a Causal Theory of Music." Paper presented at Graduate Music Theory Colloquium, Eastman School of Music. Rochester. February.

———————. 1994b. "A Non-Numerical Predicate of Wide Applicability for Intervallic Relations in Music." Paper presented at the Simposion International de Muzicologie: Muzica si Matematica, Bucharest. May.

———————. 1993. "A Nominalist Formulation of Basic Terms in Radical Behaviorist Theory." unpub. ms. Toronto: the author (formulations distributed in 10pp. handout of Jay Rahn. "Imaginary Entities in a Phenomenal Theory of Music." Paper presented at Annual Conference of Society for Music Perception and Cognition. University of Pennsylvania. Philadelphia. June).

———————. 1992. "An Advance on a Theory for All Music: At-Least-As Predicates for Pitch, Time, and Loudness." *Perspectives of New Music* 30, 1: 158–83.

Rahn, John. 1980. *Basic Atonal Theory*. New York: Longman.

Shepard, Roger N. 1964. "Circularity in Judgments of Relative Pitch." *Journal of the Acoustical Society of America* 36, 2346–53.

Skinner, B.F. 1974. *About Behaviorism*. New York: Vintage.

Stevens, Stanley Smith and Hallowell Davis. 1983. *Hearing: Its Psychology and Physiology*. 2nd ed. New York: American Institute of Physics for the Acoustical Society of America.

Footnotes

1. In this and following formulations, such a phrase as "is inherently pitched" can be replaced by such phrases as "is heard as inherently pitched", "is heard as being inherently pitched", etc.—see below. Note also that inherent pitchedness here differs from pitchedness, which, in Rahn 1992, 165, is a "property" of any thing, x, if and only if there is at least one thing, y, such that x is pitch-related to y. The subsequent theorems claimed in the latter study which depend on this definition of pitched (P) things can be proven for inherently pitched (IP) things.
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2. As defined here, IPV is more general (i.e., is less determi- nate) than NP ("is next, in pitch, to"), as defined in Rahn 1992, 172. E.g., for any things, x and y, xIPVy might hold even if xHTy, but xHTy excludes the possibility of xNPy.
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3. As defined here, PAC is more general than NICP ("is non- intervallically closer, in pitch, to . . . than to") in Rahn 1992, 172–73.
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4. Postulates are regarded here as asserting the existence of at least one thing, whereas definitions do not make such an ontological claim (cf. Goodman 1961, 6—or Goodman 1972, 343–44).
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Prepared by Natalie Boisvert, Cynthia Gonzales, and Rebecca Flore, Editorial Assistants