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Book Review

Melodic Intonation, Psychoacoustics, and the Violin by Janina Fyk. Zielona Góra, Poland: Organon, 1995. 260 pp. ISBN 83-902135-5-9. $45.00

In this substantial research monograph, Polish psychoacoustician, musicologist, and violinist Janina Fyk makes a strong case for regarding violin intonation not so much as following a static ideal of perfect tuning but rather as a dynamic, context-sensitive process. The history of theoretical and practical concerns with tuning systems goes back to antiquity, and systematic research on the topic goes back at least a century. However, most of this research has been concerned with isolated intervals, not with intonation in the context of actual, expressive performance. According to Fyk, this aspect has been especially neglected in the West while relevant research has been going on sporadically in Poland and the Soviet Union. As most of this literature is inaccessible to those not conversant with Slavic languages, it is one of the merits of Fyk's book to bring this research to the attention of Western readers while at the same time surpassing it in scope and methodological rigor. The principal achievement of this book, however, is to raise the study of intonation to the same level as that of other expressive dimensions such as timing and dynamics.

In her introduction, Fyk argues that *expressive intonation* emerged as an ideal of intonational purity only about a century ago in the wake of artists such as Carl Flesch and especially Pablo Casals. Earlier string players are said to have followed a "static model of intonation" (p. 16). Although it may be difficult to find objective evidence for this alleged change in performance practice, because it predates or coincides with the beginning of sound recordings, Fyk cites historical evidence in support of her claim. One question that immediately comes to mind is to what extent expressive intonation is linked to compositional style, particularly to the 19th century repertoire. A discussion of expressive intonation in relation to style and to contemporary "historical" performance practice is absent from the book. It is clear, however, that Fyk is concerned only with tonal music.

The governing principle of expressive intonation is said to be "tonal gravitation." Although the meaning of this crucial concept becomes clear in the course of the book, it should have been introduced more clearly; it is also missing from the subject index. Fyk writes (apparently paraphrasing Casals) that "(t)onality's 'gravitational pull' creates the attraction of a leading-note towards its tonic, however the attractions exist between all

semitones" (p. 17).[1] To exemplify the vague second half of this statement, Fyk reports that in Casals' playing "the distance between *D-flat* and *C-sharp* was larger than in the natural semitone, e.g. *C-D♭* or *C♯-D*" (p. 17), which not only strains credulity but also leaves tonal context out of the picture and fails to articulate a general principle.[2] Evidently, tonal gravitation refers to a general tendency to move the pitch of an unstable tone closer to that of a following stable tone. However, no definition of tonal stability is given, and there is no reference to relevant experimental research (reviewed by Krumhansl, 1990). There are additional instances in this book where Fyk leaves it to the reader to guess the meaning of concepts, to draw connections, or to infer experimental hypotheses, but these are problems of exposition rather than of substance.

The book consists of two brief introductory chapters, followed by six empirical studies and some final remarks. The first chapter provides a brief historical review of intonational systems and of the above-mentioned change in performance practice, just sufficient to set the stage for the empirical chapters, which include more detailed reviews of relevant literature.[3] Toward the end, the chapter degenerates into an unnecessarily detailed and rather undigested report on studies of musical emotion. Fyk may have intended this section to provide a background for her later claim (p. 34) that expressive intonation reflects the artist's emotions. However, research demonstrating that emotions can be conveyed by performance parameters such as dynamics and articulation does not automatically imply that expressive intonation, too, is reflective of emotion. This requires separate and detailed study, which remains to be undertaken.

The second introductory chapter starts off somewhat uneasily with rough parallels between music and language, followed by only a brief reference to categorical perception of pitch, which would have deserved a more detailed treatment in this context. Instead, Fyk introduces the concept of *intonational variant*, which she defines as "a narrow intonational zone within the interval category, related to a stable tendency to attribute a definite size to the given interval" (p. 31). Distinct intonational variants are said "to differentiate the interval significance to make the expressive aspect of the performance more profound" (p. 31). Following the Russian author Garbusov, Fyk postulates (at least) three variants: normal, wide, and nar-

1. Indeed, tonal "attraction" or "magnetism" would have been preferable to "gravitation," a term that implies a downward pull on the pitch continuum (cf. Larson, 1993).

2. The example would have been more convincing if it had referred to *D♭-C* (in the key of A♭, i.e., IV–III) and *C♯-D* (in the key of D, i.e., VII–I). In fact, just such an example and a more detailed discussion of Casals' concept of expressive intonation may be found in Blum (1977), a source not cited by Fyk.

3. Some relevant literature is not covered, such as the research of Elliot, Platt, and Racine (1987) and Loosen (1993).

row. A pitch discrimination threshold of 25–30 cents is assumed for tones in context, again according to Garbusov.

Subsequently, Fyk distinguishes between *acoustic* and *expressive variants* of an interval. Acoustic variants result from adjustments in interval size according to a psychoacoustic criterion of intonational purity such as the minimization of beats, as is commonly done in tuning a string instrument and in playing simple chords.[4] Expressive variants are the ones Fyk is specifically interested in. They are employed primarily in melodies and reflect "an active, emotional stance towards the act of musical communication" (p. 34). Their sizes "correspond to particular tastes and emotional states of the individual" (p. 34), which suggests—somewhat misleadingly—that the ideal of "intonational purity" they are subserving is a purely subjective one. A discussion of how expressive variants are different from simply poor intonation, with reference to the principle of tonal gravitation, would have been valuable at this point.

Fyk's empirical studies range all the way from a psychoacoustic investigation of interval tuning to an analysis of concert violinists' intonation in portions of a Paganini capriccio. Experiment 1 (Chapter 3) is a study of the tuning of isolated melodic pure-tone intervals, using the method of adjustment. Three subjects, two amateur musicians and a professional violinist, tuned intervals of an octave, double octave, fifth, diminished fifth, augmented fourth, and major seventh, going up from a variable starting pitch. The purpose of the experiment was to test two hypotheses that, unfortunately, are not stated very clearly. Fyk first discusses theories of *intervallic activity* or *stability* or (memory) *strength,* according to which certain intervals (the more active or less stable or less strong ones) have a wider "intervallic zone", that is, a larger range of acceptable intonational variants. In addition, Fyk hypothesizes that stability is influenced by musical training, so that "different musical experience may result in a different classification of musical intervals into stable and strong by individual subjects" (p. 40). In the absence of an explanation of *how* specific musical experience might modify the tonal stability hierarchy, this statement obfuscates the stability hypothesis. A later passage in the discussion (p. 54) suggests that Fyk expected intonational variability to reflect tonal consonance (the traditional correlate of interval stability) in musically inexperienced subjects, but to reflect mainly "tonal syntactic rules" (i.e., gravitation) in musically experienced subjects. That is, unstable tones may acquire greater stability by their being drawn toward a stable tone (even if that stable tone is not physically present).

4. It is not quite clear from Fyk's discussion whether there can be more than a single acoustic variant of a given interval on a given instrument. If not, "acoustic standard" (a term that actually appears on page 35) or "standard tuning" would have been preferable.

To investigate the effects of tonal gravitation on tuning, Fyk explicitly instructed her subjects to consider the diminished fifth as scale degrees VII–IV and the augmented fourth as IV–VII, and "to take into consideration the tonal gravitation and the direction of the resolution of the interval tones" (p. 42). Fyk again does not state her predictions, but she evidently expected that the diminished fifth (which resolves downward to III) would be tuned more narrowly than the augmented fourth (which resolves upward to I), and that this tendency would be most pronounced and least variable in the musically most experienced subject.

The results are not straightforward.[5] Most intervals tended to be tuned wide relative to equal temperament, which is in agreement with earlier findings that intervals larger than the perfect fifth tend to be stretched whereas smaller intervals tend to be compressed (see Rakowski, 1990). However, it is not clear which of these deviations were significant, as Fyk displays medians, interquartile ranges, and full ranges rather than means and confidence intervals.[6] Moreover, there were substantial differences among the three subjects. Only two of them (one being the professional violinist) showed the expected difference between the augmented fourth and the diminished fifth.[7] All three subjects stretched the major seventh more than the octave, which could reflect tonal gravitation as well, but again the reliability of these differences is unclear. One subject stretched the double octave by more than a semitone, but the other subjects stretched it much less.

Differences in variability are likewise difficult to interpret, since the confidence ranges of full or interquartile ranges are unknown. Particularly problematic is Fyk's apparent dissociation of interval stability and strength by considering the total range a measure of the former but the interquartile range a measure of the latter. Not only do the two ranges constitute measures of the same statistical property of the data (viz., variability), but it is far from clear how stability differs from strength at a theoretical level. In fact, Rakowski's (1990) earlier discussion of very similar data indicates that he considered stability and memory strength to be the same thing. Paradoxically, Fyk applies inferential statistics and an appropriately cautious interpretation only to the least interesting aspect of her data, the rela-

5. Figure 3.4 (p. 46) is mislabeled: It shows median deviations from equal temperament, not dispersions. Also, on page 45, the first occurrence of "diminished fifth" should read "perfect fifth."

6. Fyk (personal communication) did compute these statistics but omitted them for the sake of brevity. Interested readers may wish to contact her to obtain these data. Throughout the book, Fyk refers to total ranges as "dispersions," although this term normally subsumes any measure of variability.

7. Fyk points out twice (pp. 44, 55) that Subject 3 tuned the diminished fifth smaller than equal temperament when in fact the difference was zero or close to zero, depending on which figure is consulted.

tion between deviation from equal temperament and interval starting frequency, which tended to be positive—a result neither predicted nor explained. In view of all the foregoing, the elaborate conclusions of this chapter must be taken with a grain of salt.

Experiment 2 (Chapter 4) is a study of melodic octave intonation in two concert violinists. The purpose was to examine whether the octave enlargement observed in many previous psychoacoustic studies would also be obtained in this simple performance situation. The octaves were performed in six different ways. In one condition, going from the open A string (A_4) to the stopped E string (A_5), the open string continued to vibrate during the second tone and thus provided a simultaneous reference that was likely to encourage precise "acoustic" intonation. This was indeed the result obtained. However, significant octave stretching (judging from Figure 4.8, which again displays medians with interquartile and full ranges) was observed in only two of the other five conditions. In particular, when both notes (A_4-A_5) were played on the A string, there was no deviation from equal temperament. Rather than trying to explain this absence of octave stretching, Fyk proposes that violinists stretch octaves in order to match the timbre of the higher tone to the timbre it would have had if it had been accompanied by lower open-string resonances (p. 79). To this reader (not a violinist himself), this seems rather implausible in view of (a) the common finding of octave stretching in psychoacoustic tuning studies, (b) the relative rarity of open-string tones in violin performance, and (c) the unsupported assumption that a minute shift in pitch can cause a perceptible difference in timbre. However, Fyk's explanation is based on her practical experience as a violinist and therefore should not be dismissed lightly.

Fyk's observations on the detailed structure of violin tones are interesting, although her interpretations are no less controversial. She divides each tone into initial (attack), steady-state, and final portions. In those tones that were not reached via a glissando shift on the same string, the fundamental frequency during the initial portion often differed from that in the steady state, usually being lower rather than higher. Fyk interprets this as an *intentional* pitch correction, even though the neural feedback loop involved would have to be virtually instantaneous. She does not consider the possibility that a given pitch might be approached from above or below, in which case the observed frequency change would represent a predetermined trajectory of finger motion, not a correction. Similarly, in the final portion of the first tone of an octave, Fyk often finds a pitch change in the direction of the following tone. Again, she interprets this as an intentional "announcement" and "auditory [*sic*] anticipation" of the following pitch (p. 78), whereas it seems much more likely that this is an automatic motor anticipation, namely the incipient movement of the finger or hand to the next position—a form of coarticulation. Regardless of the correct interpreta-

tion, however, these are interesting phenomena, and it is good to see them documented so carefully.

In Experiment 3 (Chapter 5), two groups of musicians (12 string players and 12 players of other instruments) judged the intonational accuracy of a subset of the melodic octaves recorded in Experiment 2. Both groups tended to prefer octaves closest to "acoustic" tuning (1200 cents), regardless of the production condition (i.e., with or without open string vibrating, with or without glissando on the same string).[8] Fyk does not provide an explanation for this finding, and one is led to wonder whether the original violinists would have judged their own octaves similarly in a playback condition. The absence of perception-production reciprocity with regard to intonation, especially in string players, is puzzling. Fyk draws a number of conclusions, each supported only by snippets of data.

In Experiment 4 (Chapter 6), the same two concert violinists as in Experiment 2 performed two four-note melodies on the D string five times, both with and without vibrato. One melody consisted of an augmented fourth and its resolution (F_4-B_4-C_5-E_4) and the other of a diminished fifth and its resolution ($F\sharp_4$-C_5-B_4-G_4). Fyk prefaces the experiment with a detailed review of previous studies of expressive intonation. According to her, Western studies focused primarily on the extent to which intonation approached a particular fixed tuning system, whereas Eastern European researchers (Garbusov in particular) "considerably outdistanced" (p. 90) their Western counterparts by focusing on intonational variants as a "manifestation of a purposeful artistic effect or proof of creative intonation" (p. 95). However, the crucial question in my mind is how a string player gets from one creative intonation to the next without drifting and going sharp or flat. There must be some intonational standard around which all this creativity varies, and any thorough study must address *both* the nature of that standard and the nature of the variation. Fyk would probably agree that this was essentially her purpose, although she overemphasizes the (previously neglected) creativity aspect.

The results of the experiment are complex and are described in great detail. On the average, the intonation of the successive intervals approached Pythagorean tuning when played with vibrato, but equal temperament when played without vibrato. Both the augmented fourth and the diminished fifth tended to be stretched (relative to equal temperament); the difference between them does not look significant, although it is (predictably) interpreted by Fyk. The following minor second in each melody was compressed,

8. The upper right-hand panel of Figure 5.2 plots incorrect data. The correct values may be found in Figure 5.1.

although in the first melody this tendency was present only with vibrato.[9] The intonation of the final interval depended both on the melody and the manner of execution. The most striking finding is the reciprocal relationship between the first two intervals, which generally tended to be balanced around equal temperament. Indeed, a more detailed correlational analysis across individual performances showed significant negative correlations between the sizes of the first two intervals in the first melody (where they moved in the same direction) and positive correlations in the second melody (where they moved in opposite directions). Fyk attributes this to "intonation feedback": "[A] violinist assesses the size of the currently performed interval and accordingly corrects the size of the interval that is to follow" (p. 120). She concludes that "a melody as the superior whole determines the selection of interval sizes." She does not consider, however, the possible hierarchical intervallic structure of melodies. It seems to me that the violinists intended to maintain a pure intonation of the perfect fourth or fifth between the first and third melody tones, and that the correlation between the first and second intervals resulted from moving the second melody tone up or down within this superordinate, more stable interval. It would be useful to consider intervals between nonadjacent tones in future analyses of this kind.

In Experiment 5 (Chapter 7), the judges of Experiment 3 evaluated the intonation of the initial interval in the Experiment 4 melodies as performed by one of the two violinists. The results are not easy to interpret because not only the initial interval but also the following intervals varied in size, in a partially correlated fashion. On the whole, the listeners preferred wide intonation for the augmented fourth and narrow intonation for the diminished fifth, close to the Pythagorean ideals. Based mainly on circumstantial evidence, Fyk concludes that the judgments were based on the sizes of both the first and the second interval, and that these intervals constituted a "perceptual entity" (p. 134), although she does not refer either to the interval spanned by that entity or to hierarchical structure. Her conclusions seem reasonable, even if they are not forced by the data. She goes considerably beyond the data, however, when she infers the existence of "intonational illusions, i.e., erroneous perception of size when the interval is a part of a larger perceptual entity" (p. 135). It is not clear to me in what way the judges may have heard the interval sizes incorrectly.

9. Fyk's use of interquartile ranges is particularly bothersome in Figure 6.7, because there were only five observations per interval. The interquartile range thus was simply the difference between the second- and fourth-largest values, which of course is a highly unreliable measure of variability. In one condition, for example, there was a total range of 30 cents but an interquartile range of only 3 cents.

The final and most comprehensive study (Chapter 8) consists of a detailed analysis of the same two master violinists' performances of the Theme and Variation X from Paganini's famous Capriccio No. 24, played at different tempi and in different pitch registers. In addition, the performers themselves provided a detailed evaluation of the accuracy of their own intonation. These rich data are presented in enormous detail, and only a few aspects can be mentioned here. Several results observed earlier were replicated, such as the tendency for intervals larger than the perfect fifth to expand and for smaller intervals to contract and the tendency for adjacent intervals to exhibit compensatory adjustments in precise intonation. Not surprisingly, intonation was found to be more variable at a faster tempo. Although, on the average, the musicians' intonation was closest to the Pythagorean system (with equal temperament not far behind), Fyk concludes that "this tendency does not mean a tendency to play in a given tuning system. It may only be observed that the size of intervals in a given tuning reflects the rules of tonal syntax and meets the requirements of the musical context to a greater extent than any other interval size.... [It is] a secondary phenomenon, the effect rather than the cause" (p. 212). Fyk seems to associate "tuning system" with "fixed intonation" and therefore downplays this aspect of the data, just as she previously downsized Western research on intonation because of its overriding concern with static tuning systems. However, it seems to me that both aspects of intonation—the contextual variants and the underlying ideals—are equally important and inseparable; their relation is analogous to that between expressive timing and basic tempo (Repp, 1994). The underlying constancies are not epiphenomenal but essential to maintaining equilibrium and preventing drift. Fyk seems to acknowledge this in her final remarks where she refers to intonation as "a self-regulating system" (p. 222).

In perhaps the most important figure of this long chapter (Fig. 8.19), Fyk displays medians and interquartile ranges of the same intervals occurring in different contexts, and she concludes that many intervals exhibit two or three "intonational zones," as originally postulated by Garbusov. However, the data hardly justify this conclusion: The total distribution of sizes for each interval seems reasonably normal, and a much larger number of contexts and observations would be required to support a division into discrete zones. Nor does such a division seem to be really necessary; it is sufficient to note the contextual flexibility of intonation, which Fyk has demonstrated very convincingly.

In summary, despite this reviewer's incessant carping, this is a stimulating book filled with interesting observations and thought-provoking discussions. Had these studies appeared in mainstream journals, their presentation might have been more concise, their hypotheses spelled out more clearly, their statistical analyses more effective, and their conclusions more

cautious. However, there are some advantages to the current format. The data are offered in almost raw form (as well as in various reductions), so that interested readers can dig around to their heart's content and reach their own conclusions if they do not agree with Fyk's interpretations. Fyk is not only meticulous in her attention to the data but she also informs her discussions with a musician's insights. There is a palpable involvement and enthusiasm in her writing that more than makes up for occasional flights of fancy or unclear passages and that might have been squelched by dour peer review. The studies reflect a large amount of dedicated work, carried out over a number of years in several different laboratories.[10] The organization of the book is very clear. The translation from Polish (a translator is acknowledged) is good and idiomatic, with only occasional minor slips. The many tables and figures are well designed and contain only few errors, some of which have been noted here. The editing is generally of high quality—not perfect, but no worse than that of some Western publications. The book is recommended to music psychologists and psychoacousticians as well as musicians, especially string players. It is a valuable contribution to the study of intonation and musical expression and should be in the personal library of everyone interested in these areas.[11,12]

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10. Fyk might have mentioned that preliminary results of several of her studies were reported in Rakowski's (1990) summary of recent Polish intonation research, which is absent from her list of references.

11. Thanks are due to Janina Fyk for graciously commenting on a draft of this review and helping reduce some of its excesses.

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