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The Avoidance of Inner-Voice Entries: Perceptual Evidence and Musical Practice

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Experimental evidence has shown that entries of inner voices are more difficult to perceive than entries of outer voices in multivoiced music. A study of voice entries in 75 fugues by J. S. Bach shows no significant avoidance of inner-voice entries in three- and four-voice textures. However, in the case of five-voice textures, Bach does demonstrate a significant reluctance to have a voice enter in an inner-voice position. This finding is consistent with the hypothesis that Bach endeavors to minimize perceptual confusion in his polyphonic works as the textural density increases.

A stereotypic feature of polyphonic music is the constant introduction and retirement of voices throughout the course of a work. Two categories of voice entries can be distinguished according to the relationship between the region of pitch activity (tessitura) of the entering voice, and the tessituri of voices that are already present in the texture. If the tessitura of the entering voice is embedded between active voices both higher and lower than itself, the entry may be dubbed an "inner" voice entry. Conversely, if a voice enters with a tessitura above that of the highest currently active voice, or lower than that of the lowest currently active voice, then the entry may be dubbed an "outer" voice entry. In a study of the perceptability of concurrent voices, Huron (1989) found that entries of inner voices were significantly more difficult to identify than entries of outer voices. Specifically, the mean reaction time for the identification of inner-voice entries was found to be more than twice the comparable value for outer-voice entries.

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In addition, significantly more of inner-voice entries failed to be identified by subjects when compared with outer-voice entries.

It is appropriate to ask whether this apparent perceptual difficulty plays any role in the construction or organization of musical works. That is, do composers (consciously or unconsciously) compose their works in a manner that minimizes the perceptual difficulty of hearing inner-voice entries? To this end, a study of voice entries was performed on a selection of 75 fugues by J. S. Bach. Forty-eight fugues were taken from the two volumes of *Das wohltemperierte Klavier,* 15 fugues from *Die Kunst der Fuge,* the 2 ricercari from *Das musikalische Opfer,* and a random sample of 10 organ works of varying textural densities (BWVs 532, 534, 538, 540, 547, 549, 552, 574, 578, and 677).

Defining Entry Sites

An initial difficulty arises in defining sites in the scores that may be considered *bona fide* voice entries. When a voice first appears in the music, there is no question that the site may be deemed a true voice entry. However, it is more difficult to determine whether a previously active voice has withdrawn from the texture for a sufficiently long period of time for its reappearance in the texture to be deemed once again a voice entry. Brief rests frequently occur in midphrase without interrupting the sense of continuity; thus musical material immediately subsequent to a brief rest ought not to be regarded as an entry.

One possible solution to the problem of identifying entry sites is to have an experienced music theorist mark them according to intuition. This task was carried out by the first author for the 24 fugues in volume one of the *Well-tempered Clavier.* A drawback to this approach is the possibility that the theorist may choose sites according to formal considerations rather than perceptual considerations. For example, statements of a fugal subject might elicit the manual identification of an "entry" even when the figure is embedded in a context within which the voice was never perceived as ever having withdrawn from the texture. On the other hand, a purely operational procedure for identifying voice entries may fail to take advantage of the musician's superior experience and intuition.

An especially good method for identifying entry sites would be to formulate a precise procedure which would largely replicate the results of the theorist's intuitive choices. That is, an attempt would be made to define a procedure that would produce virtually the same results as the musician, but would have the virtue of being a transparent method that would be known to have been applied consistently.

One way to define operationally the retirement of a voice is to set a

threshold value for accumulated notated rest durations. Once this rest duration threshold has been exceeded, any ensuing activity in that voice would constitute a voice entry. Unfortunately, this method will produce a bias in alla breve works, that is, works effectively notated at approximately half tempo. An alternative operational method for defining voice retirement is to set a threshold value for contiguous vertical sonorities containing rests in a given voice. Any change of note in any of the voices is deemed to produce a new vertical sonority. Counting vertical sonorities containing rests in a given voice has the advantage of circumventing the problem of alla breve notations. The intention is to define a voice entry as the onset of any voice that previously had not been present in the texture, or that had been inactive for X or more vertical sonorities before its reentry. Various values for X were then explored.

It was found that a threshold of 10 vertical sonorities produced a selection of voice-entry sites similar in both number and position to entries selected manually. In fact, 97% of the entry sites selected manually also were selected by this operational procedure. As the threshold for the number of vertical sonorities was varied, it was found that between 8 and 12 vertical sonorities there was little difference in the number and position of entry sites selected. So for the purposes of this study, a voice entry was operationally defined as the onset of any voice that previously had not been present in the texture, or that had been inactive for 10 or more vertical sonorities before its reentry.

Comparison of Inner- and Outer-Voice Entries

According to the above criterion, over a thousand entry sites were identified from a validated data base of 75 works. Nearly half of these sites were of no analytic value because they entailed only one or two active voices. By definition, the advent of a single voice must be an outer-voice entry—as is also the case with two voices. Only with the advent of a third voice is there a possibility that the voice may occupy either an inner or outer position.

Given a certain number of currently active voices, it is trivial to calculate the probability of a new voice being either an inner-voice entry or an outer-voice entry. In order to disprove the null hypothesis, we would look for ratios of inner- to outer-voice entries that differ significantly from a random distribution where all voice positions were equally probable. In the case of three-voice textures, the ratio of inner-voice to outer-voice entries should be 1:2—that is, given high, mid, and low voice positions, the probability of a random entry occurring in the mid voice is one-third. By a similar logic, it is evident that the ratio of inner- to outer-voice entries in four-voice textures would be 2:2; in the five-voice condition the ratio would be 3:2, and in the

TABLE 1
Voice-Entry Data in 75 Polyphonic Works by J. S. Bach

No. of Voices	Number of Inner-Voice Entries	Number of Outer-Voice Entries	Predicted Ratio of Inner to Outer	*df*	χ^2 Value	Significance
3	107	225	1:2	1	0.1822	n.s.
4	154	175	2:2	1	1.3404	n.s.
5	18	27	3:2	1	7.5000	$p < .01$

NOTE. Occurrences of voice entries with predicted entry-condition ratios.

six-voice condition the ratio would be 4:2. Table 1 synopsizes the measured results for all 75 works. For each entry condition, chi-squared values have been calculated in order to determine statistical significances. Note that the entry condition (i.e., the number of active voices at an entry site) must not be confused with the nominal number of voices in a work. A five-voice fugue will have many circumstances where there are three-voice entry conditions.

In the amalgamated data, the three- and four-voice results are statistically insignificant; in the three- and four-voice textures, the proportion of inner- to outer-voice entries is no different than what would be expected by chance. However in the five-voice situation, a significant discrepancy appears between the predicted ratio and the measured ratio. The relative proportion of inner-voice entries is markedly less than would be expected; the null hypothesis is rejected at better than the 0.01 confidence level. This result suggests that the avoidance of inner-voice entries becomes pressing only when the textual density exceeds four concurrent voices. Not enough data exist to confirm this view with regard to six-part writing: only three outer-voice entries and four inner-voice entries were identified in the six-voice condition. However, the ratio of inner- to outer-voice entries in the modest data available for the six-voice condition does display a skew toward the avoidance of inner-voice entries—and so is at least consistent with the hypothesis that Bach avoids inner-voice entries in textures exceeding four concurrent voices.

Conclusion

An analysis of 75 fugues of homogeneous timbres by J. S. Bach shows that Bach neither favors nor avoids inner-voice entries in three- and four-voice textures. However, in the case of five-voice textures, Bach does show

a significant reluctance to have a new voice enter in an inner-voice position. In light of experimental evidence concerning the perceptual difficulty of identifying inner-voice entries, this finding is consistent with the hypothesis that Bach endeavors to minimize perceptual confusion in his polyphonic works. That Bach displays this aversion in the five-voice situation, but not in the three- or four-voice situations, suggests that the strategy to avoid inner-voice–engendered perceptual confusion may be necessary only in the denser textures.[1]

Reference

Huron, David. Voice denumerability in polyphonic music of homogeneous timbres. *Music Perception,* 1989, *6*(4), 361–382.

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