Musicians' and Nonmusicians' Aural Perception of Orchestral Instrument Families

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The purpose of this study was to examine aural perception in a selective listening task using a Continuous Response Digital Interface (CRDI). Undergraduate college students (60 musicians, 60 nonmusicians) listened to an excerpt from Billy the Kid *by Aaron Copland. Subjects indicated focus on instrumental family by manipulating the indicator of the CRDI. "Sound intervals" were determined by changes in predominant instrument family in the orchestral texture. Families were divided into five categories: (a) brass, (b) percussion, (c) woodwinds, (d) strings, and (e) all. The "all" category indicated focus on three or more families simultaneously (e.g., tutti). Results were based on examination of subjects' category selections in terms of percentages of time focused on each category within each interval. Analyses of cumulative seconds across all intervals indicated that nonmusicians focused on brass and percussion longer than did musicians. Musicians focused on strings longer and selected strings more frequently than did nonmusicians. Musicians also indicated focus on three or more families simultaneously more than did nonmusicians.*

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Music listening is generally regarded as an important aspect of most musical experiences. Its inclusion in national, state, and district educational standards for music instruction suggests its importance as an integral component in musical literacy. In support of the music listening experience, Reese (1983) designated this mode as the primary source through which the aesthetic experience occurs. Reese further indicated that educators must encourage students to listen perceptively to music, focusing on individual elements that contribute to the exploration of human feeling.

Listening preferences might possibly be affected by one's knowledge of formal aspects (Bradley, 1972; May, 1985), personality traits (Hedden, 1973), and musical understanding (Bartlett, 1973). Environmental factors such as socioeconomic status have seemingly affected aural skill development in that middle-class students have performed significantly higher than have lower-class students (McDonald, 1974).

Although Hufstader's (1977) formulation of a learning sequence provides a structure indicating perceptive and cognitive capabilities of children as related to musical elements, the inclusion of music listening in the classroom is sometimes ineffective because there are few evaluation instruments for effectively measuring what students are hearing during the course of a listening experience. In addition,

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most listening-measurement techniques require a person to engage in some other activity while he or she is to be listening carefully to music.

Herberger (1983) suggests that educators are capable of obtaining necessary information to determine students' feelings and understanding of the music only through class discussion. Attempting to modify this problem among students, Herberger used a procedure that involved written data describing selected elements and emotions associated with the music experience during its occurrence. Approximately 50% of the subjects were able to use the facts and relationships learned through the experience in subsequent tasks.

One of a variety of techniques educators use to encourage on-task listening in the music classroom has been the use of listening guides. Though most of these teaching aids have been carefully designed and developed by competent music educators, existing research has revealed inconsistencies as related to the effectiveness of listening guides in the music listening experience (Geringer & Nelson, 1980; Kostka, 1987a, 1987b; Prince, 1972; Zumbrunn, 1972). The most controversial issue concerning the use of listening guides is that students may neglect their own perceptions and interpret the music based on the instructor's bias. It may be that there are numerous ways of perceiving that are appropriate, yet unexamined, because of a priori determinations of musical structure that are imposed by a listening guide, teacher, or tradition of visual imagery.

Research by Montgomery (1978) suggests that children and adults perceive changes similarly in music that may be identified and measured. Discrimination in music listening related to changes in focus of instrumental families might provide information regarding basic listening skills so that meaningful instruction might be developed and ultimately lead to improved listening skills.

Perhaps one of the most important questions that needs to be addressed in order to plan and implement instruction in music listening more effectively is the identification of variables that differentiate the perceptions of trained listeners and the perceptions of untrained listeners. Although informal observations of students' perceptions of music are made regularly by teachers at all levels of instruction, it seems useful to approach this area of investigation in a more formal, empirical setting, isolating various music elements for study. This study addresses the aspect of focus of attention to instrument family as a means of assessing the perceptions of trained and untrained listeners with regard to their focus of attention. As subjects listened to a 6-minute example, they indicated aural focus on separate families and combinations of families by manipulating a Continuous Response Digital Interface (CRDI). Specific questions addressed included the following: (a) Do musicians and nonmusicians attend similarly to instrument families in an orchestral excerpt? (b) Do musicians and nonmusicians change their aural focus on instrument families with similar frequency? and (c) Are musicians and nonmusicians able to estimate the amount of time they spent in each category over the 6-minute period?

METHOD

One hundred twenty undergraduate college students, 60 musicians and 60 nonmusicians, served as subjects. Musicians were students enrolled in a music degree program, and nonmusicians were students who had had 2 or fewer years of music training. All subjects were drawn from undergraduate classes at a large university and were selected from education classes, performing ensembles, and university music classes.

The first 6 minutes of *Billy the Kid* by Aaron Copland was chosen as the music example for the study. This composition was thought to contain a sufficient number of different combinations of performing instrument families so that subjects' discriminating aural abilities might be successfully measured. The excerpt provided a variety of response options, including instrumental solos, instrumental doublings within and among families, and a variety of textures from monophonic to full orchestra passages. Copland's use of familiar folk tunes was thought to be appropriate to maintain the attention of nonmusicians.

Montgomery (1978) indicated that changes in music may be perceived similarly by children and adults. In reference to the current research, "changes" are defined as those points at which the subject's attention shifts from one instrument family to another. The music score was divided into sections according to clear points of change in the orchestral texture (e.g., strings to woodwinds, tutti to solo). The resulting sections, each of which comprised a texture different from its preceding section, were labeled "intervals."

The experimenter consulted a group of experts consisting of two doctoral students and one university faculty member to determine whether the delineation of intervals seemed appropriate. The three individuals were given a color-coded score of *Billy the Kid* with the experimenter's indicators of changes. As experts listened to the example, they indicated agreement or disagreement with each of the labeled changes in the musical score. They were also given the option to add any points of change in aural focus that were not indicated by the experimenter. Responses were included in the final draft when at least three experts agreed on the point at which a change occurred. Expert agreement determined that the 6-minute excerpt consisted of 35 intervals. Reliability among experts as related to changes in aural focus was 94%.

The primary experimental measuring device for this study was a Continuous Response Digital Interface (CRDI). The CRDI contains an eight-bit analog-to-digital converter that functions primarily to convert a voltage range of 0-5 volts to a digital signal ranging from 0–255. Voltages were divided into five different zones, which were labeled with the names of the four instrument families and "all" (as described previously). CRDI measured the total time spent within each category per interval, the frequency of category selection, and the duration of each category selection. Because the CRDI measured subject responses in real time, it allowed direct comparison of responses with the musical score (see Figure 1).

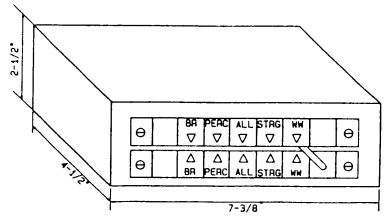

Figure 1. Continuous Response Digital Interface.

Other equipment used during the experiment included a microcomputer with dual disk drive and keyboard (Sanyo MBC-1250), a stereo cassette deck (AIWA, Model SD-L5OU), a stereo amplifier (Rotel, RX-402), and 2 headsets (Koss, Pro/4AA).

When they entered the experimental area, subjects were informed that the task to be performed involved orchestral listening. Poster illustrations were displayed on two walls of the room to provide visual aid for students who were unfamiliar with orchestral instruments and families. After being informed of the task, subjects were introduced to CRDI. Instrument families on CRDI were easily distinguished by abbreviated labels and a color coding system consistent with the wall posters. To attain familiarity with the manual operation of CRDI and orchestral instrument families, subjects listened to four 15-second examples from Benjamin Britten's *A Young Person's Guide to the Orchestra.* Each instrument family was demonstrated separately: (a) woodwinds, (b) brass, (c) strings, and (d) percussion. Subjects read prepared instructions and moved the horizontal indicator of CRDI to the appropriate instrument family when instructed to do so. Subjects then practiced random movements so that the experimenter was satisfied that each individual was competent to operate CRDI.

Following introductions to the instrument families and CRDI, subjects were presented the 6-minute aural example from *Billy the Kid.* Instrument families indicated by CRDI were the following: (a) brass, (b) percussion, (c) all, (d) strings, and (e) woodwinds. Subjects were instructed to move the horizontal indicator to the corresponding tab of the family on which their attention was focused at each moment during the excerpt.

When three or more families were heard simultaneously, subjects were to move the indicator to the "all" category. At the conclusion of the task, subjects completed a questionnaire concerning musical experience, preferred music for leisure listening, time spent listening to music weekly, recognition of aural example, general liking of the excerpt, and perceptions of instrument focus.

Each subject listened to the excerpt and moved the dial to the instrumental family of focus. Information provided through second-by-second analysis included: (a) percentages of each interval subjects focused on each of the instrument families, (b) total seconds spent in each family, and (c) frequency of change in aural focus.

RESULTS

The unequal lengths of the designated intervals required the initial analysis to be based on percentages of assessed attention within categories per interval rather than on cumulative seconds per interval. Percentages were calculated for comparison for both groups of subjects in each of the 35 intervals. Examination of individual intervals indicated that perception data as related to time spent in aural focus within instrumental families per interval most often represented one of three descriptions: (a) aural focus concentrated in one of the five instrumental families (the mean percentage of time in an interval for any one family was equal to or exceeded 50%), (b) aural focus concentrated somewhat equally in two families, and (c) aural focus distributed somewhat evenly among three or more families (i.e., the range of at least three families was not greater than 15 percentage points). I analyzed the 35 intervals to determine which of the three descriptions was most relevant to each individual interval for both musicians and nonmusicians. For musicians, there were 16 intervals of aural focus concentrated in one instrument family, 8 intervals of focus in predominantly two families, and 7 intervals of a somewhat equal distribution spread over three or more families. In comparison, nonmusicians focused aural attention

in one instrument family during 17 intervals, two families in 6 intervals, and three or more somewhat equal families in 7 intervals.

Musicians and nonmusicians agreed as to prominent families of aural focus within intervals in 60% of the 35 intervals. Informal comparison of the mean percentages of time spent in each response category per interval indicated that musicians and nonmusicians seemed to focus similarly throughout the experimental excerpt. In addition, further examination of both groups' data in each interval indicated that responses within the two groups in each individual interval were clearly related.

For each of the 35 intervals, a Pearson product-moment correlation was calculated between the responses of musicians and nonmusicians with regard to the mean number of seconds devoted to each of the five response categories. As is evidenced by the overall high mean correlation ($r = .91$), musicians and nonmusicians focused aural attention similarly in the 6-minute excerpt. A correlation of .99 was calculated in the interval of greatest similarity wherein aural focus in both groups was predominantly in one category, while a .60 correlation was obtained in the interval of greatest difference, where focus was spread among all categories.

Additional analysis concerned the cumulative seconds focused within each of the instrument families during the entire 6-minute example (see Table 1). As indicated, nonmusicians listened to brass and percussion longer than did musicians. Musicians seemed to focus on three or more instrument families ("all") and strings longer than did nonmusicians. Both groups focused a similar number of total seconds on the woodwind family, though nonmusicians listened to woodwinds slightly longer than did musicians.

Musicians and nonmusicians seemed to select the brass, percussion, all, and woodwind categories with similar frequency, and musicians seemed to select strings more often than did nonmusicians. The mean durations of nonmusicians' brass and woodwind selections (i.e., the length of time during which subjects kept the indicator in each of these categories before moving to a different category) were longer than the brass and woodwind selections of musicians. Both groups focused for similar durations in the percussion, all, and string categories.

Both groups of subjects indicated simultaneous focus on three or more families ("all") longer than any other category. Overall, the mean duration of each indicator position was longer in the all and woodwind families and shortest in the percussion family. Strings were selected with a greater frequency than any other category, but for shorter durations than brass, all, and woodwind families. Both musicians and nonmusicians changed their aural focus of instrument families with similar frequency during the example.

One section of the questionnaire administered following the session asked subjects to estimate the total time they had spent listening in each instrument family. Subjects were asked to rank-order the individual families from one to five and approximate the time spent in each. Thirty-six percent of the musicians were able to perform this task correctly (i.e., the rank orders in their estimates and actual times were identical), whereas only 12% of the nonmusicians were successful in the task.

In terms of liking, musicians and nonmusicians rated the aural example favorably and similarly. Twenty percent of the musicians were able to name the composition as compared to 5% of the nonmusicians. Approximations by musicians regarding weekly music listening time indicated that they spent 20.4 hours weekly

in music listening; nonmusicians stated that they spent 14.8 hours weekly. Both groups listed a variety of musical styles when asked to give a preferred listening style.

Table 1
Time Spent Listening and Frequency of Selection by Groups and Categories

Instrumental category	Total seconds (Excerpt length = 360 seconds)	Frequency of selection	Mean duration
Brass			
Musician	*M* = 37.28 *SD* = 17.10	*M* = 12.9 *SD* = 5.21	*M* = 2.75 *SD* = 1.68
Nonmusician	*M* = 52.55 *SD* = 21.68	*M* = 13.25 *SD* = 6.85	*M* = 4.38 *SD* = 3.54
Percussion			
Musician	*M* = 17.95 *SD* = 10.98	*M* = 11.07 *SD* = 6.49	*M* = 1.3 *SD* = 0.7
Nonmusician	*M* = 28.3 *SD* = 15.51	*M* = 13.41 *SD* = 7.7	*M* = 1.95 *SD* = 1.4
All			
Musician	*M* =154.75 *SD* = 52.05	*M* = 15.88 *SD* = 5.51	*M* =10.12 *SD* = 4.75
Nonmusician	*M* =133.32 *SD* = 45.38	*M* = 15.95 *SD* = 5.71	*M* = 9.13 *SD* = 5.02
Strings			
Musician	*M* = 60.93 *SD* = 28.55	*M* = 21.38 *SD* = 8.67	*M* = 2.58 *SD* = 1.42
Nonmusician	*M* = 50.23 *SD* = 23.92	*M* = 16.62 *SD* = 7.67	*M* = 2.87 *SD* = 1.76
Woodwinds			
Musician	*M* = 89.08 *SD* = 19.8	*M* = 14.58 *SD* = 6.18	*M* = 6.78 *SD* = 4.46
Nonmusician	*M* = 95.6 *SD* = 19.21	*M* = 13.57 *SD* = 6.59	*M* = 8.17 *SD* = 4.29

DISCUSSION

This study was designed to explore aural perceptions of musicians and nonmusicians as demonstrated by manipulations of CRDI. Both groups seemed

to focus for similar percentages of time in each of the orchestral instrument families per sound interval. A general comparison of subject responses within intervals suggested that musicians' and nonmusicians' responses were similar. Because the data have been interpreted somewhat cautiously in determining relationships in aural perception between groups of subjects, the importance of the study may be most aptly realized by examining musical content within intervals in which musicians' and nonmusicians' responses were dissimilar.

As Table 1 indicates, nonmusicians focused on brass, percussion, and woodwinds longer than did musicians. Score analysis indicated that during some intervals when brass, woodwinds, and strings were in unison, nonmusicians focused aural attention on brass while musicians focused on strings. Nonmusicians focused on brass when strings and brass were doubled. The same tendencies for focus away from strings were evident when woodwinds doubled the strings during various intervals throughout the excerpt. During the same intervals, musicians frequently focused on strings when they doubled brass and woodwinds.

Nonmusicians may pay less attention to the tone color of strings while selecting the more obvious brass, percussion, and woodwind instruments, especially since the strings were frequently doubled by woodwinds and brasses. Musicians may have been more adept at recognizing the string sound amidst the doublings.

In *Billy the Kid,* Copland used a variety of percussion instruments such as bass drums, woodblocks, and triangles that clearly penetrate the pitched instruments of the orchestra during performance. Nonmusicians seemed to focus on the percussion section longer and remain focused for slightly longer durations than did musicians. Musicians may regard the percussion family as one that functions to punctuate melodic lines and rhythmic accompaniments with varied tone color, and thus may not have devoted as much attention to this section. Nonmusicians' responses may have been affected by a lack of sophistication in making immediate aural adaptation to other families following the pronounced use of percussion in the composition.

Nonmusicians frequently focused on woodwinds when musicians indicated simultaneous focus on at least three instrumental families and selected the "all" category. Nonmusicians focused on woodwinds longer when instruments within this family were playing in unison. Imitation within the woodwind family might have been an additional factor in attention focus.

Musicians' tendencies to focus in the "all" category longer than nonmusicians could indicate that musicians are better able to hear three or more families simultaneously. Broadbent's (1971) filter theory would suggest that both groups were skilled in rapid attentional time-sharing. As subjects focused rapidly on different families, musicians indicated that they were hearing at least three different families simultaneously, and indicated "all." Musicians seem to be able to recognize various combinations of instruments in varying textures more readily than do nonmusicians. Although both musicians and nonmusicians focused longer in the "all" category than in any other, nonmusicians seemed to focus on instruments performing the melody during some intervals when musicians chose the "all" category.

Several subjects indicated that they were much more attentive to the music and listened more carefully when required to manipulate the CRDI than while listening more passively. The use of the CRDI may have contributed to heightened attention because subjects were given a defined task while listening.

Recall of rank-ordered categories according to total time spent listening was approximately three times more accurate among musicians. Possibly having

structured sounds in more meaningful aural hierarchies than have nonmusicians, musicians demonstrated greater accuracy in the rank-ordering process. In addition, nonmusicians' lack of familiarity with the musical example may have affected their recall abilities.

Implications for future research using a Continuous Response Digital Interface are seemingly limitless, as it records simultaneous subject/stimulus events and requires minimal motor movement. CRDI's basic components may be constructed rather easily by those who are mechanically adept. The versatility of the device is evident in that it is capable of analyzing on the basis of a continuum or in predetermined categories. Operant nonverbal responses minimize confounding variables related to motor and verbal interference.

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