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The Effects of Orchestration on Musicians' and Nonmusicians' Perception of Musical Tension

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Abstract

The purpose of this study was to examine the effects of orchestration on musicians' and nonmusicians' (N = 40) perception of musical tension. Participants were asked to register their perceptions of tension using the Continuous Response Digital Interface dial while listening to three orchestrations (full orchestra, brass quintet, and solo piano) of the movement *Bydlo* from Mussorgsky's *Pictures at an Exhibition*. The full orchestra and brass quintet stimuli were digitally altered to have the same amplitude, frequency, and duration as the orchestration for solo piano. Pearson product-moment correlations between the participant groups were statistically significant at the $p < .001$ level and highest for brass quintet ($r = .96$), followed by full orchestra ($r = .91$), and piano ($r = .78$). Musicians perceived the piano orchestration as being the least tense of the stimuli while nonmusicians felt this was the most tense, perhaps suggesting a difference in perceived tension response based on timbre.

Introduction

Investigators have successfully identified and measured emotional, aesthetic, and artistic responses to various musical stimuli (Aiello & Sloboda, 1994; Lychner, 2008; Madsen & Fredrickson, 1993; Sloboda, 1991; Sloboda & Lehmann, 2001). Through the use of equipment that allows for real time tracking of responses to music, researchers are exploring how individuals and groups perceive and interpret musical information as it is presented during the act of listening. Of these studied responses, the perception of musical tension has received considerable attention.

In one of the first experiments that continuously measured perceived musical tension, Nielsen (1987) had participants squeeze or release a pair of spring-loaded tongs to indicate their level of perceived musical tension in a recording of the first movement of Haydn's *Symphony No. 104*. While Nielsen found that no single aspect of the music was responsible for determining a participant's perception of tension, he concluded that there was a correlation among tension, thematic development, and dynamics. Madsen and Fredrickson (1993) replicated and extended this study by having participants manipulate a Continuous Response Digital Interface (CRDI) to record their perceptions of tension instead of the mechanical tongs. A high degree of similarity was found between the responses in both studies, suggesting that even though different devices were manipulated, musical tension could be measured successfully with the CRDI.

The acceptability of using the CRDI as a valid and reliable measure of music perception has been well established. Recent studies involving the CRDI have measured participants' perception of dynamics (Misenhelter, 2001), tempo (Crist, 2000), aesthetic experience (Coggiola, 2004; Geringer and Madsen, 2003), and preferences towards musical stimuli (Byrnes, 1997; Gregory, 1994). Scholarship supporting the ability of the CRDI to reliably gather continuous responses has been clearly documented (Geringer, J. M., Madsen, C. K., & Gregory, D., 2004; Gregory, 1995).

Research has illustrated that neither musical training nor age significantly affect listeners' perception of musical tension. Fredrickson (1997) reported that students in grades 2, 5, 8, 11, and 12 displayed similar patterns of perceived tension when listening to the first movement of Haydn's *Symphony No. 104*. When comparing these elementary, middle school, and high school students to university-level music majors who underwent the same research protocol, Fredrickson found similar correlations among all age groups. Fredrickson (2000) also noted no significant differences between adult musicians and nonmusicians' perception of tension when using western art selections composed by Haydn, Holst, and Shostakovich.

Most research concerning tension perception in music has involved classical music. In an attempt to determine if differences in tension perception could be found when using non-classical music, Fredrickson and Coggiola (2003) presented music majors and nonmajors with two stylized jazz recordings of *St. Louis Blues*. As found in previous studies involving just classical music, no noticeable differences between the two groups' perception of tension was detected, indicating that perhaps genres outside of classical music do not elicit dissimilar tension responses.

Individuals' perception of musical tension has also been shown to be unaffected by prior knowledge or performance of the presented stimuli. Fredrickson (1999) compared perceived tension responses between individuals in a university and high school wind ensemble who had rehearsed and performed Gustav Holst's *First Suite in E-flat* and students in a university choral ensemble who did not have the same performance experience. Results indicate that prior performance experience did not affect how participants perceived musical tension. Similarly, Brozak (2002) reported that instrumental music majors were no different in their overall perception of tension than nonmajors when responding to Percy Grainger's *Irish Tune from County Derry*. The responses of participants who had previously performed or listened to the piece did not differ significantly from the responses of those who were unfamiliar with the stimulus.

Although age, musical training, and knowledge of the presented stimulus have produced no noticeable differences in how individuals perceive musical tension, researchers have yet to explore the effects of orchestration on the perception of musical tension. When planning a new piece of music, composers often begin with a specific performance medium (e.g., string orchestra, woodwind quintet) in mind. Many ensemble directors and musicians would agree that orchestration and instrumentation decisions made during the compositional process are reflective of a composer's desire to have their piece sound a specific way. Would changes in the orchestration (i.e., arranging a composition for different sets of instruments) of the same piece of music produce differences in how individuals perceive musical tension?

The purpose of the present study was to investigate the effects of orchestration on musicians' and nonmusicians' perception of musical tension. Specifically, I sought to explore if changes in orchestration would affect musicians' and nonmusicans' perception of tension in different versions of the same piece of music. A secondary purpose was to discern whether musicians and nonmusicians differed in their ability to recognize that they were listening to multiple orchestrations.

Method

Participants

Participants (N = 40) were undergraduate and graduate music majors (musicians, n = 20) enrolled in a large southern university and students enrolled in a music fundamentals course at a large southern community college (nonmusicians, n = 20). All nonmusicians in this study reported having less than three years of formal musical training.

Music Stimuli

The stimulus selected for presentation was Bydlo, a two-minute, forty-five second movement from *Pictures at an Exhibition*. Originally composed as a solo piano suite by Modest Moussorgsky in 1874, *Pictures at an Exhibition* has been reorchestrated for many performing media. In addition to the original piano version, the well-known orchestration for full orchestra by Maurice Ravel was chosen, as well as Elgar Howarth's arrangement for the Phillip Jones Brass Quintet. Musical features of the chosen selection included varying tempi, tutti playing, wide dynamic ranges, a gradual intensification to a predictable climax, and a piano resolution. Stimuli were presented to participants individually. Three different presentation orders were used to help control for order effects.

To make the recordings as similar as possible, the full orchestra and brass stimuli were digitally altered with the computer software program *ProTools* to have the same duration, amplitude, and key as the piano stimulus. It is important to note that the form of the piece (i.e., the specific timing of all musical events) remained constant across all three orchestrations. The equalization of these musical parameters was intended to focus listeners' attention on orchestration differences between each of the three stimuli rather than differences in the timing of musical events or dynamics.

Procedure

Prior to testing, participants were read the following directions:

> This study is an attempt to provide information concerning perception of tension in music. You will be using the dial in front of you to record your responses to three musical selections. As you listen, move the dial in relationship to what you consider to be various degrees of musical tension. Please start with dial on the far left of the curve. When the music starts, move the dial towards the right as you hear musical tension increase and towards the left as you hear musical tension decrease. You may move the dial as far and as often as you want. There are no right or wrong answers. After listening to the musical selections, you will be asked to give written responses to a few questions. If you have any questions, please ask them now.

Since previous research involving tension perception provided no operational definition of tension, none was provided in this study. However, some participants did ask for an explanation of the term. In these instances, I told the participants to create and apply their own definition.

Data collection

Data for each individual were recorded continuously by the Continuous Response Digital Interface at the rate of one sample per second, providing a mean value across time for each of the three stimuli. At the conclusion of stimuli presentation, participants completed a short researcher-developed questionnaire. The first question asked, "How many musical selections did you hear today?" Following this question, participants were asked to "Briefly describe what made these musical selections sound the same and\or different." The final question asked was, "What does the term orchestration mean to you?"

Results

The perceived tension data from each individual were combined within groups to produce a group mean score for each second of the stimuli. Figures 1 and 2 show musicians' and nonmusicians' responses to the three stimuli. Overall, nonmusicians' collective responses varied more than musicians' and displayed a wider use of the CRDI scale. While the increase in perceived tension follows a similar pattern of escalation towards the climax for both groups, musicians perceived these climactic points differently than nonmusicians. Musicians felt the height of tension for the brass, piano, and orchestra stimuli occurred at approximately 89, 99, and 113 seconds, respectively. Nonmusicians, however, were less varied in their perceptions of the moment of greatest tension with the brass, piano, and

orchestra stimuli registering 101, 105, and 110 seconds, respectively. Further visual analysis of the graphs also revealed nonmusicians' perception that the piano stimulus was the most tense, while musicians perceived the piano as being the least tense.

Data comparing musicians' and nonmusicians' tension response for each of the three stimuli was graphed and subjected to Pearson Product-Moment correlations. As evidenced by the graphs (Figures 3 and 4), an extremely high degree of similarity existed for responses to the brass quintet *(r* = .96) and orchestra (*r* = .91) stimuli. Even though musicians perceived the piano stimulus to be the least tense among the three stimuli and nonmusicians considered the same stimulus to have the most amount of tension, a strong correlation was found between their responses (*r* = .78, Figure 5). All correlations were statistically significant at the $p < .001$ level. Interestingly, the contour of the last twenty seconds of the piano stimulus flattened out considerably for both musicians and nonmusicians, indicating a sustained level of perceived tension that is not present when compared to the orchestra and brass quintet stimuli responses.

Discussion

Unlike most extant research involving tension perception, participants in this study were asked to listen to multiple orchestrations of the same piece of music in an effort to discern what similarities or differences existed between their responses. Results indicated that musicians' and nonmusicians' responses maintained similar contours for the three stimuli regardless of which orchestration was heard. While correlation coefficient values indicated a strong relationship between musicians and nonmusicians for all three stimuli, visual inspection of the graphs revealed interesting differences between musicians and nonmusicians in their perceived tension responses.

Musicians displayed less variability in their responses to the three orchestrations than nonmusicians, who exhibited greater use of the CRDI dial. Although group tension responses for musicians deviated less in terms of magnitude than nonmusicians, inspection of Figures 1 and 2 shows that nonmusicians' responses among the brass quintet, orchestra, and piano stimuli are more uniform in contour than musicians' responses. Nonmusicians also displayed less variability among the stimuli at the average height of musical tension (i.e, musical climax) and the subsequent decline of tension than musicians did. One possible explanation may be that the musicians in this study were more sensitive to differences in timbre based upon their previous performing experience or particular area of expertise (brass, strings, or piano). Perhaps musicians' experience on a particular instrument may help explain why the climax of each orchestration yielded more disparate responses for musicians than nonmusicians.

Regardless of which orchestration was heard, nonmusicans' tension responses followed a general three-part structure: (1) a quick rise in tension at the introduction, (2) a long plateau which led to a sudden and quick escalation of tension to the climax, and (3) a steady decline of tension until the end. In contrast, musicians tended to perceive a longer increase in tension from the introduction to the climax, followed by a de-escalation to the end (this pattern is least apparent in responses to the brass orchestration, in which the tension contour of musicians' responses were remarkably similar – almost identical in fact – to those of nonmusicians). During the build-up to the climax, musicians tended to perceive more subtle nuances in tension. Nonmusicians' perception of a more sudden and dramatic increase in tension leading to the climax may have led them to use a greater range of the CRDI device than musicians.

The variability of mean scores across time between musicians and nonmusicians raises an interesting question: Why did participants respond somewhat differently to three orchestrations of the same piece of music? While previous tension perception investigations have shown similar differences in variability when using participants with diverse levels of musical training, most of these studies used a single stimulus when comparing groups. It is possible that the differences in timbre and orchestration between multiple versions of the same piece were responsible for the two most salient findings of this study: (1) greater variability in tension responses among the three orchestrations and (2) a greater use of the CRDI dial by nonmusicians than musicians.

Data obtained from the post-experiment questionnaire illustrates that musicians were easily able to discern that three orchestrations of the same piece of music had been presented. All of the responses to: "Briefly describe what made these musical selections sound the same and\or different" included references to orchestration, instrumentation, and timbre. Trained musicians may have intuited the intent of the study and their written comments reflected their formal understanding of how music is constructed. Musicians' lack of variability among the graphed responses to the three orchestrations may have indicated their belief that the orchestrational differences among the pieces should not have greatly affected their tension responses.

These differences were less notable for nonmusicians whose responses included "musical instruments," "how the pieces were put together," and "sounds" in describing the differences among the orchestrations. The difference between the two groups' responses was most evident in the final question, "What does the term orchestration mean to you?" All twenty musicians gave a correct response (e.g, arranging a composition for different instruments) while only five of twenty nonmusicians provided a similarly accurate answer. However, nonmusicians' inability to define this specific musical term may not have been a valid indicator of their ability or inability to discriminate among the presented stimuli.

Frederickson (1997) suggested that slightly higher recorded tension levels for musically inexperienced participants might indicate "slightly less discrimination of the musical stimulus" (p. 50). Given the written and graphic responses of the nonmusicians in this study, his belief does not appear to be congruent with these research findings. Specifically, when comparing nonmusicians' responses from the beginning of each stimulus through the fifty-second mark, Figure 2 shows that the initial perceived tension differences are widely varied. These differences are not as pronounced from the time of the average perceived height of tension (around 107 seconds) through the end of the piece. Nonmusicians' responses during the build-up to the perceived climax may have been influenced more heavily by the different timbres of the orchestrations than musicians'.

Future research involving tension perception might focus more on providing meaningful ways in which to measure, analyze and describe data. According to Frego (1999), "reducing the continuous subject response for each stimulus to one data point obscures the differences that individual subjects may indicate across time" (p. 41). Studies including the graphic display of individuals' data might best illustrate the degree to which these perceptions differ and offer insights into what musical parameters exert the greatest influence over individuals' perceptions of musical tension. Furthermore, few studies measuring tension perception have used stimuli outside of western art music. Research including different genres of music seems prudent given the diversity of potential study participants.

While investigations in this area show few differences in the way populations perceive musical tension, educators and composers stand to benefit by additional research that explores how individuals perceive musical tension. For example, composers might consider using certain timbres in their music to influence audience members and performers' emotions on the basis of research participants' tension data. In addition, educators could explain to their students how timbre and orchestration appear to affect perceptions of what they are hearing, playing, and experiencing. The continued refinement of ways in which to analyze musical tension will remain an important line of inquiry in music perception research.

Figure 1
Musicians' Tension Responses to Three Stimuli

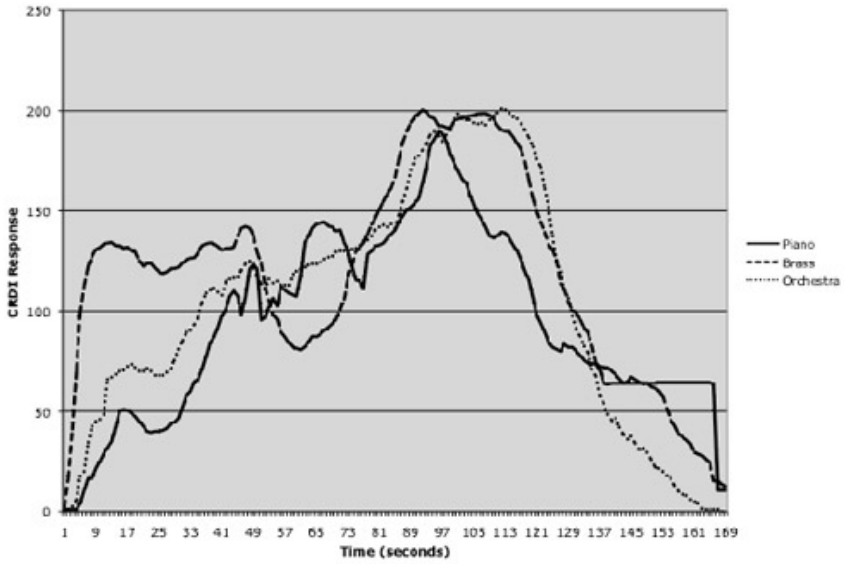


Figure 2
Nonmusicians' Tension Responses to Three Stimuli

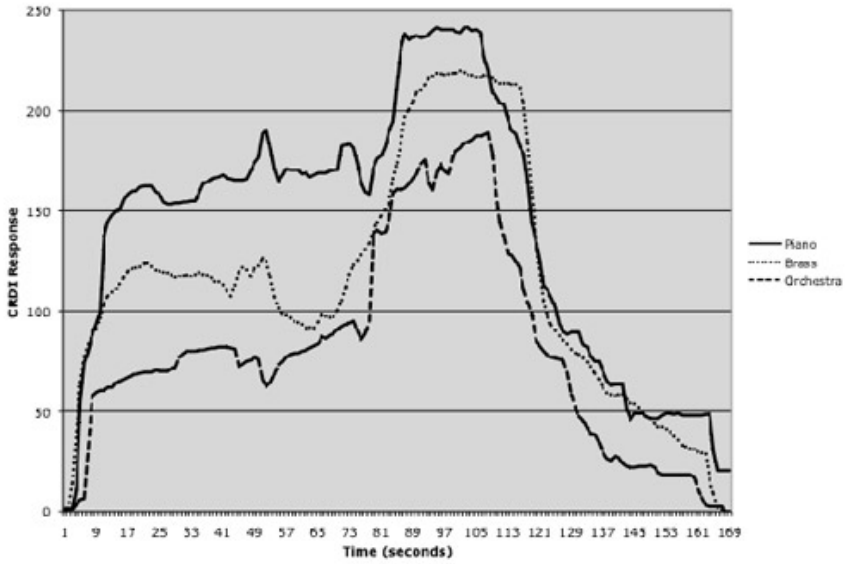


Figure 3
Musicians' and Nonmusicians' Tension Responses to Brass Stimulus

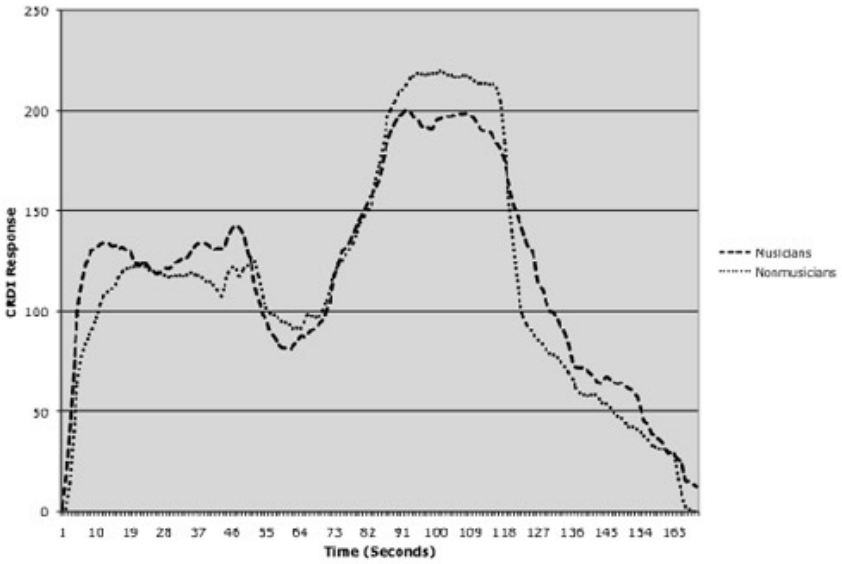


Figure 4
Musicians' and Nonmusicians' Tension Responses to Orchestra Stimulus

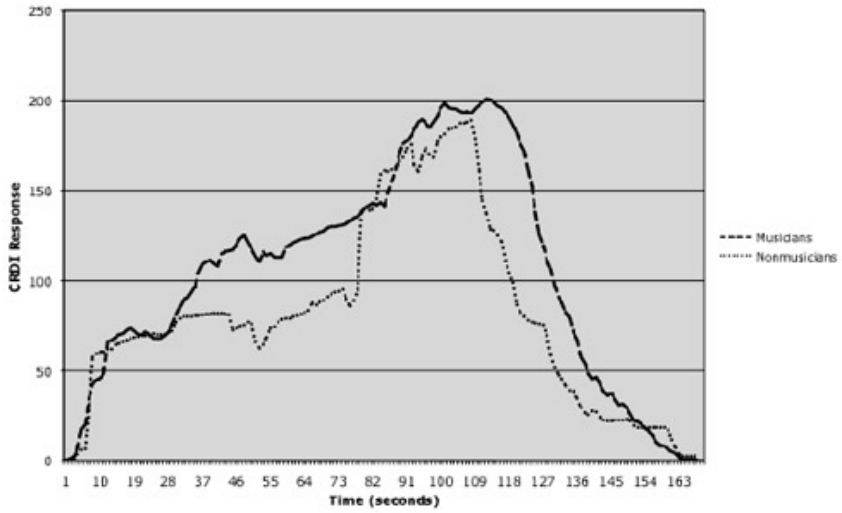
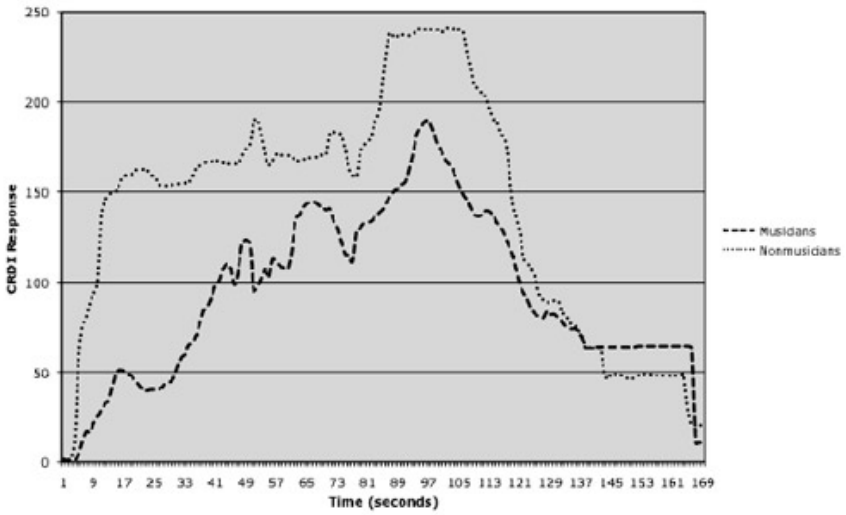


Figure 5
Musicians' and Nonmusicians' Tension Responses to Piano Stimulus



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