Perception of Instrumental Spacing in Composers' Orchestration Styles

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Introduction

Orchestration is a complex process of utilizing aspects such as pitches, durations, and timbre to create various auditory outcomes. Because of orchestration's multifarious aspect, many different elements might contribute to how listeners perceive the sounds that they hear. Orchestration treatises however usually comprise a) factual observations, b) prescriptives and prohibitions, c) musical examples to be emulated (Sandell, 1995, p. 210), instead of an approach that provides precepts and tenets for the organization of sound colour according to its own musical logic (Slawson, 1985, p. 5). According to Meyer, style is a "replication of patterning … that results from a series of choices made within some set of constraints" (1989, p. 3). There are various levels of constraints — principles that govern perception and cognition of musical patterns, rules that are learnt within a musical tradition, and strategies that are choices made within the possibilities established by the rules of the style. The strategies chosen by individual composers thus create specific styles that they might be identified with. Orchestration theorists often claim that composers have an individual style in their instrumental spacings — how the notes within a chord are distributed among the instruments — when orchestrating a chord; or that there are certain ways of realizing chords that are characteristic of different stylistic periods. Phrases such as "they must think, feel, and hear as if they were writing in the Baroque idiom" (Adler, 2002, p. 365) or "[The combination of] flute, clarinet, and bassoon in a three-octave spread, [is] one of Mozart's favourite colour combinations" (p. 234) pepper conventional orchestration textbooks.

More recently, researchers have attempted to look at various aspects involved in orchestration and how they function in auditory perception, specifically in auditory scene analysis (Goodchild, 2017; McAdams, 2013). As listeners receive auditory information, they attempt to form useful representations in order to make sense of the world around them and auditory fusion and segregation are perceptual processes that occur in auditory scene analysis (Bregman, 2002). Hearing different notes together as a chord is an instance of auditory fusion, and certain information may become salient as mental representations of particular chords are formed. Style identification may also be explained by a Parallel Distributed Processing (PDP) framework. PDP models "assume that information processing takes place through the interactions of a large number of simple processing elements … each sending excitatory and inhibitory signals to other units" (McClelland, et al, 2002, p. 62). The identification of a style will only take place when the threshold for sufficient information is crossed. Based on the above-mentioned orchestration literature, there appears to be a belief that different ways of instrumental spacing create perceptible differences in styles that are unique to certain composers. If there are tangible differences, it follows that these differences due to instrumental spacing might provide sufficient information for the activation of a mental representation of the style and as such, they will be perceptually salient to listeners.

Hypotheses

As Mozart and Haydn are often described to have different orchestration styles but yet belong to a stylistically similar period with similar instruments in the orchestra to work with, it is hypothesized that there may be an observable difference in instrumental spacing from their orchestral scoring. In order to assert the presence of a difference in the music, not only does the theoretical analysis of the chords have to reveal a difference, listeners should be able to perceive the differences as well. We therefore hypothesize consistent differences in Mozart's versus Haydn's instrumental spacing, both (a) observable from their orchestral scores, as well as (b) perceptible to listeners when presented in a listening experiment.

Method

For this study, final chords from each movement of both Mozart's and Haydn's symphonies are used. This is because final chords in the symphonies of the Classical period are usually quite consistent — ending on the tonic, being the final of a harmonic movement towards closure, utilizing most or all of the instruments. A single final chord also offers greater control against any other confounding variables such as melodic movement, voice leading, and so on. A total of 30 final chords from 13 different symphonies of Mozart and Haydn were selected (60 chords in total, 26 different symphonies). These chords were controlled for similarity in instruments used: for instance, certain chords by Mozart with clarinets amongst them were discarded. As the keys used were not very varied — most of them were in the keys of D major, G major, C major, A minor and so on — the exact number of chords in each key were not specifically controlled for because there was enough representation amongst each of the keys. It was difficult to find chords with the exact number of notes across similar instruments, and as instruments used were thought to be a more salient aspect, note numerosity was not controlled for in this study.

Score analysis

Final chords of each movement from a number of Mozart and Haydn symphonies were selected and analyzed. Symphonies in which certain instruments were present in one but not the other composer were discarded such as those of Mozart that included the clarinet as the presence of it may provide information that is not related to

instrumental spacing for the listener regarding the identity of the chord. There were also certain final chords that were simply a unison on the tonic and these were not used as well.

Experimental stimuli

Chords for the stimuli were synthesized with sounds from the Vienna Symphonic Library (VSL) to remove any possible extraneous effects that might occur if actual recordings were used. They were all standardized to four beats long at 40 bpm and taken from the samples of the *mf* dynamic level. Reverb was added to yield a more realistic-sounding result.

Participants

9 trained musicians in a graduate course on theory and perception from McGill University participated in the experiment. One of the participants specialized in early music and self-reported having a good knowledge of the transition into the Classical style but not an encyclopaedic knowledge of Haydn or Mozart, while another had never played any classical music but had some knowledge of Mozart's symphonies. The other seven participants all reported having some familiarity with these two composers.

Procedure

The experiment was conducted in a web-based platform. Participants visited the experiment web-page using their browser, and were instructed to wear headphones throughout the experiment so that they could hear the whole orchestral range. The experiment was comprised of a training phase followed by a test phase. In the training phase, participants listened to ten final chords from symphonies by Haydn and ten by Mozart. Subsequently, in the test phase, participants were presented with forty different final chords by Haydn or Mozart (twenty chords from each composer) and had to respond by choosing between Haydn and Mozart, the composer they believed the chord was composed by. Participants were also asked to enter a confidence level for each chord on a scale of 1 (not confident at all) to 7 (very confident). The following parameters were randomized for each participant: the order of composers in the training phase, the order of each composer's stimuli in the training phase, the order of stimuli in the test phase, the visual order of composers in the test phase.

Following the test phase, participants responded to a post-experiment questionnaire that contained three questions: (1) What helped you tell the difference between the Mozart and Haydn chords? (2) If you had more training, do you think it would help you perform better? (3) Before taking part in this experiment, how familiar were you with Haydn's and Mozart's symphonies?

Results and Discussion

An analysis of the orchestral score elucidated some differences between Mozart's and Haydn's orchestration (Fig. 1). Mozart's chords appear somewhat fuller in the middle range and seems to favour more brass sounds. Haydn's chords on the other hand seem to be more widely spaced, with the middle range less heavy than Mozart's chords. These differences however seem quite subtle and it may be unlikely for a listener to pick them out. Also, even though this may be a trend that is observed in many of Mozart's and Haydn's chords, they are by no means entirely consistent. Even with a close reading of the scores, there are many chords that are indistinguishable based solely on their instrumental spacing. There is also no clear difference in the number of notes each composer tends to use — there is a greater variance within composers than between them — thus note numerosity is unlikely to influence identification of orchestration style in final chords.

The total correct responses for both Mozart and Haydn chords were pooled for each participant because the study aimed to find out if participants were able to distinguish accurately chords composed by different composers rather than compare which composer was better identified. Due to the small number of participants, they were not divided into groups with training or no training in Mozart and Haydn chords but instead, 0.5 was assumed to be the mean for chance performance and used to compare with the means of the participants correct responses in a one-tailed *t*-test. The mean accuracy score was found to be not significantly different from chance performance of 0.5 ($M = .525$, $SD = .0884$), $t(8) = .849$, $p = .211$.

Within the sample of test chords, there were several that exhibited high accuracy amongst participants' responses and several that had low accuracy. In a comparison of the high accuracy chords with the training chords, some trends emerged (Fig. 2). Chords with a greater prominence of woodwinds tended to be identified as Mozart's and chords with more brass as Haydn's. Interestingly, this was not the trend observed for the chords in the training phase. It may be that prior knowledge of Mozart and Haydn, predisposed participants to judge certain characteristics as belonging to Mozart's style and others as Haydn's.

The close to chance performance of the participants (Fig. 3) may be related to a few different factors. Firstly, ten training chords may be too little for listeners to learn to identify the "style" of a composer. Although the participants were all music students, they did not report to have extensive training in orchestration styles of these

composers. A listener who has more training in orchestration or knowledge about these composers might exhibit a different response. Confidence ratings by the participants reflected this, with a mean of 3.67 out of 7. The Pearson product-moment correlation that was ran to determine the relationship between accuracy of responses and confidence level showed no significance (Fig. 4 and Fig. 5), for Mozart (r = -.171, n = 9, p = .660); and for Haydn (r =.327, n = 9, p = .390). From the post-experiment questionnaire, participants had varying degrees of knowledge in Haydn and Mozart symphonies but none reported a high level of expertise. All the participants felt that a more extensive training might help them differentiate the chords better.

Secondly, although different composers might have different styles in orchestrating, information from instrumental spacing of a single chord alone might not be sufficient for identification of composer style. Based on the PDP model, the perception of style identity will only be activated when the threshold for sufficient information is crossed. It appears that instrumental spacing, even as it is pertinent to style identification, may be insufficient on its own. With other information such as instrumental use, voice leading tendencies, harmonic and melodic movements, dynamic shapings and so on, identification of a style of orchestration might be more easily attained.

Interestingly, from the post-experiment questionnaire, participants were highly discrepant in their report of what they thought chords by Haydn and Mozart sounded like. For instance, some felt that Mozart's chords were more "closed" while others felt that there was more "separation"; some thought that Haydn preferred woodwinds in the highest notes while others thought he preferred the brass. This suggests that the ten training chords might not be sufficiently representative of each composer's style, and that a greater number of hearings was required for participants to discover any consistent patterns that might be present. It may also suggest that Mozart and Haydn's chord spacing styles are not as distinct as some scholars suggest.

Conclusion, Contributions, and Limitations and Future Research

Due to the constraints of experiment implementation, only a limited number of chords by two composers from a single historical period were used. In using only final chords, other factors that influence orchestration style might not be illuminated. As identification of orchestration style may be a complex interaction of instrumental spacing, harmonic and melodic movement, voice leading, overall range of the chords, and other factors, the effect of instrumental spacing alone may not be sufficient to activate processes for style identification. The training phase with only ten chords from each composer might also be insufficient for different stylistic patterns to be discerned.

Future experiments can include a greater number of composers from different periods, as well as other aspects of orchestration such as how instruments are being used over an entire phrase. More chords can be given at the training phase, and different types of training can also be looked at, such as having varying degrees of feedback in either the training or the testing phase. Chords composed by the experimenters can also be created, to allow for systematic manipulations to be made to the instrumental spacing and other aspects that play a part in the discrimination of chords. Further research might also be carried out to explore what aspects of orchestration contribute to perception of style identity by listeners and how much contribution arises from each of the different aspects.

If there are salient perceptual features in orchestration, and these elements could be explicated, it will contribute to one aspect of an orchestration theory that is built upon precepts of logical musical organization rather than one that is based on examples and descriptive observations. Having such a theory is useful not only in terms of studying compositions from composers of the past, but also in having a system with which to manipulate instruments and sounds so that composers might achieve a novel set of desired sounds.

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Appendix: Figures

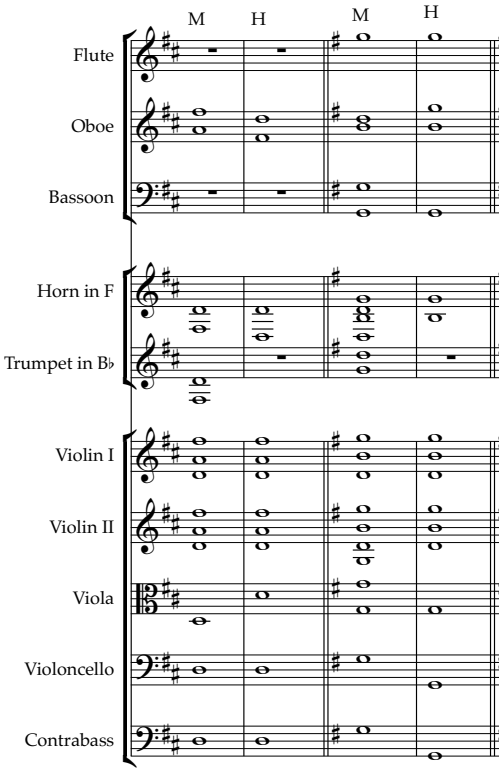

Figure 1. Two pairs of chords used for the training phase.

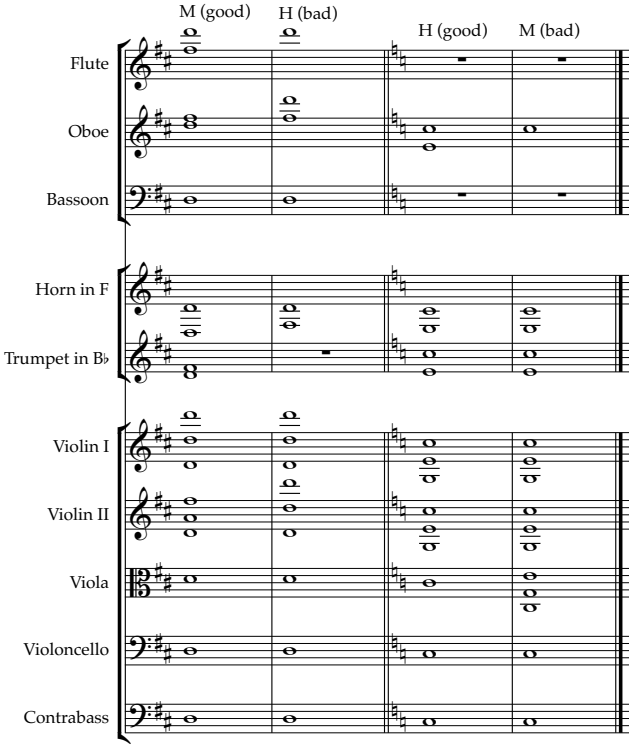

Figure 2. Mozart's and Haydn's chords identified with high and low accuracy.

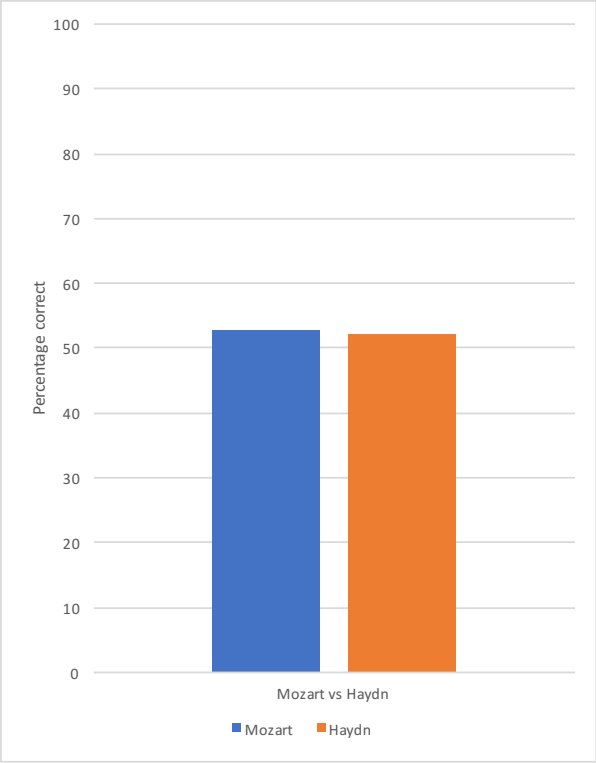

Figure 3. Percentage of correct responses for Mozart and Haydn chords.

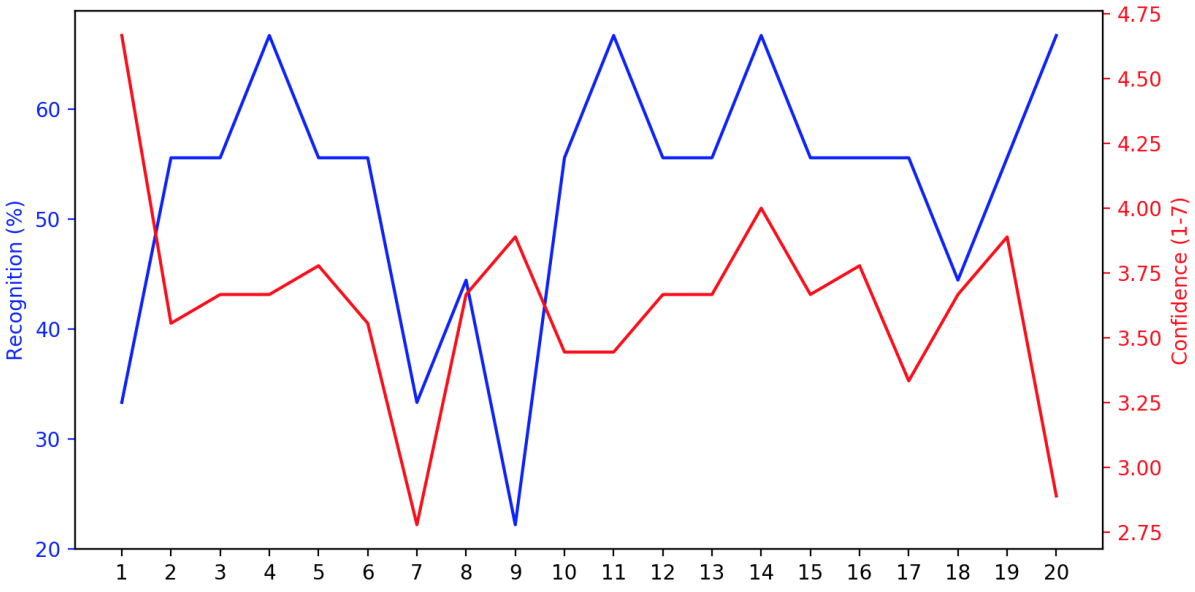

Figure 4. Individual chord accuracy for Mozart with confidence level.

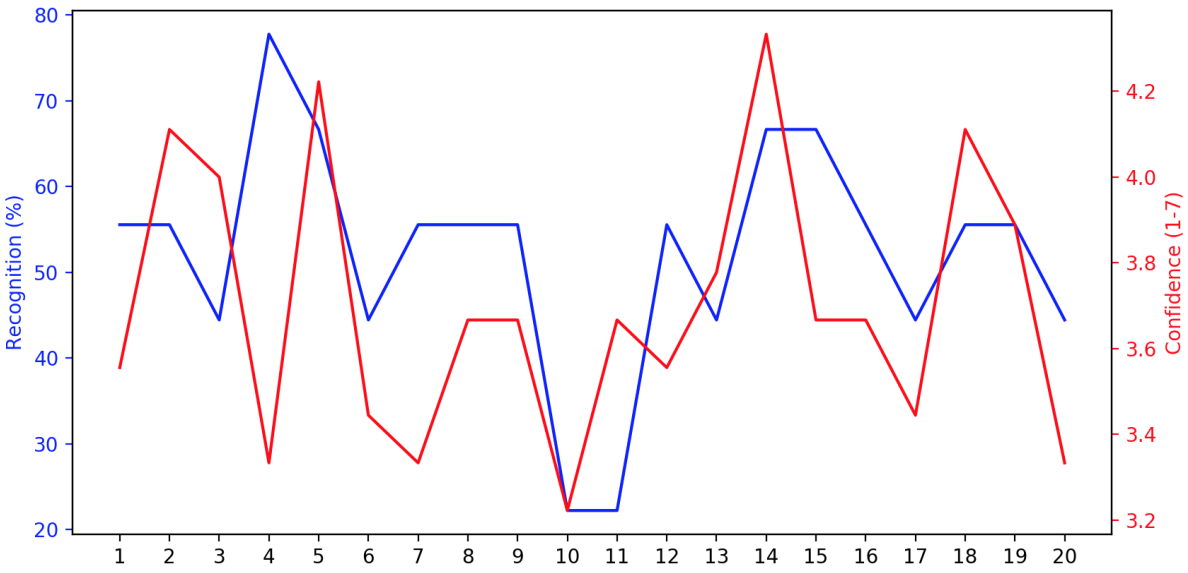

Figure 5. Individual chord accuracy for Haydn with confidence level.