

The Effect of Articulation Style on Perception of Modulated Tempo

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Abstract:

We investigated the effect of legato and staccato articulation styles on the perception of modulated tempos. Ninety music majors served as participants. Listeners heard music examples that had been selected from two pieces, each of which included staccato and legato passages. Excerpts were presented to listeners in three conditions of tempo modulation: gradual increases, gradual decreases, or no change. Modulations were produced in small increments so that listeners would not notice any abrupt change in tempo. Results indicated that articulation style and direction of modulation affected listener perception of tempo, and these two factors interacted significantly. All staccato stimuli were judged as increasing in tempo more than legato stimuli; however, differences between the two articulation styles were perceived as larger in tempo-increase examples compared to the no-change and tempo-decrease examples. Implications for performance practice and teaching are discussed.

Article:

The study of perception of ongoing temporal events in music is an important aspect of understanding both music performance and listeners' reactions to that performance. One of the most salient features of the music stimulus concerns the rate of presentation, that is, the tempo adopted by ensembles to perform the music. Obviously, there are many factors to consider in the decision for a particular tempo, such as the composer's intention, the conductor's interpretation, the performers' capabilities, and so on. Decisions must also be made about more subtle aspects of tempo, such as rubato and ritardando. Furthermore, musicians must be aware of unintentional performance tendencies, for example, propensities to rush the tempo in loud and fast sections, or to slow the tempo in particularly difficult sections. To what extent do such decisions and tendencies of performers affect listeners' judgments of tempo? Are there additional contextual factors? In the present study, we investigated whether the articulation style of the music affects the tempo perception of musician listeners.

Research into tempo preferences has shown consistent patterns among listeners. Multiple investigations by LeBlanc and colleagues as well as others have shown that tempo affects preferences. LeBlanc (1981), LeBlanc and McCrary (1983), and LeBlanc, Colman, McCrary, Sherrill, and Malin (1988), for example, found that faster tempos corresponded to higher preference ratings in comparisons between excerpts from different pieces. Geringer (1976) found that music major listeners preferred faster tape speeds of recorded orchestral music compared to unaltered speeds. Wapnick (1980) was able to isolate tempo and pitch effects, and he used piano excerpts as stimuli. Listeners preferred faster tempos of the familiar excerpts. Findings of Sims (1987) and Brittin (2000) indicated that children may acquire an association of increased preference and increased tempos by third or fourth grade. Geringer and Madsen (2003) found that music majors listening to an entire symphonic movement (Haydn's Symphony no. 104, first movement) showed slightly higher levels of aesthetic response during the latter part of the movement in a version with very gradual tempo increases compared to versions that were unaltered or with gradual decreases in tempo.

A large body of research literature also exists concerning the perception and performance of modulated tempos. Several studies found that musicians' performance of tempo tends toward acceleration (Drake, 1968; Killian,

1985; Kuhn, 1977; Kuhn & Gates, 1975). Correspondingly, listeners have exhibited greater acuity in detecting tempo decreases than increases within a broad middle range of tempos (Kuhn, 1974; Madsen, 1979; Wang & Salzberg, 1984). At tempo extremes, however, listeners have shown accurate discrimination of increases in very fast tempo excerpts and decreases in originally slow-tempo excerpts (Brittin, 1992; Yarbrough, 1987). Sheldon (1994; Sheldon & Gregory, 1997) investigated listener accuracy and response latency in tempo modulation discrimination. Responses were different among the degrees of tempo change in both increasing and decreasing examples, and interactions were found between education level and tempo change.

Subsequent investigations extended aspects of the above studies and showed that specific music characteristics of the excerpts themselves influence perception and preferences. Geringer and Madsen (1987) altered tempos of recorded popular music ($\pm 12\%$) and presented excerpts to 500 listeners ranging from fifth grade to university age. Participants showed marked preferences for unaltered versions compared to both increased and decreased tempo versions. In contrast to the consistent preferences shown for tempo increases, these results were attributed to possible effects of excerpt familiarity and/or generic style. Kuhn (1987) and Duke (1989) found that the level of melodic activity or ornamentation also consequentially affects tempo perception. The speed of the melodic rhythm influenced perceptions of relative tempo more than differences in beat notes. Faster melodic rhythms were judged as being faster than slower melodic rhythms regardless of actual beat tempo differences.

Additional possible effects of specific music context and/or styles have been recognized in several studies, but not experimentally manipulated (Duke, Geringer, & Madsen, 1988; Geringer & Madsen, 1984). Wang's (1983) listeners demonstrated greater accuracy identifying increases in tempo rather than decreases, a result attributed to an effect of style of specific pieces on tempo perception. Wang and Salzberg (1984) also found that the musical style of excerpts contributed to perceptions of modulated music tempos in addition to other factors.

The present study is an investigation of the effects of articulation as one specific aspect of musical style on tempo perception. We have not found previous research regarding possible effects of articulation on listeners' tempo judgments. The problem of this study was to determine whether legato or staccato articulations affect the perception of musician listeners regarding tempo of ongoing music excerpts. The following specific questions were asked: Will experienced listeners judge excerpts with staccato articulation differently than excerpts with legato articulation in presentations that increase gradually in tempo, decrease gradually in tempo, or do not change in tempo? Will listeners demonstrate differential preferences regarding tempo modulations for the two articulation styles?

METHOD

Upper-division undergraduate and graduate students ($N = 90$) enrolled in music degree programs at a large state university voluntarily participated. Students were tested in four groups in the same room used daily for music classes, a space that seats approximately 30 students. The classroom sound system was used to present stimuli (Sony STR DE598 amplifier, Sony CDP361 CD player, and Paradigm speakers).

Music Stimuli

We searched for music examples that exhibited the following characteristics: pieces that contained both legato and staccato sections with similar instrumentation, tempos, and rhythmic activity. The latter two in particular have been shown to affect judgments of beat speed (cf. review of literature). After discussing the sorts of examples we were seeking with music theorists, musicologists, and conductors, we identified two works that contained brief sections that met our criteria: Aaron Copland's *Appalachian Spring*, and the *First Suite in E-flat* by Gustav Holst. Table 1 shows the specific sections, original tempos, and performances of these works.

Each of the four excerpts chosen was slightly longer than 20 seconds in duration and contained complete musical phrases. Excerpts were primarily conjunct melodies, and both accompaniment and melodic parts were performed with the designated articulation. The excerpts were copied to a computer hard drive from the original source material on compact disc. We tested the original examples and found no consistent tempo increases or decreases. Excerpts were then modified to create a total of three versions of each: examples that gradually

increased in tempo, examples that gradually decreased in tempo, and examples that did not change in tempo from the original version. We wanted both the tempo increases and decreases to be gradual enough so that musician listeners would not be able to hear any particular increment of change but sufficient enough so that during the duration of the excerpt, it would be noticeable with careful listening that the example had sped up or slowed down.

Basing our work on previous research that used abrupt tempo changes of $\pm 12\%$ (Duke, Geringer, & Madsen, 1988; Geringer & Madsen, 1984), incremental change during extended listening (Geringer & Madsen, 2003), and additional pilot study, we modulated the increased or decreased examples by 6% from the original tempo. Using computer software (Amazing Slow Downer, 2004), tempo of examples was changed (without changing pitch levels) in 6 discrete increments of 1%.

During the first 5 seconds of each example, no changes were made so that listeners could establish the original tempo. Following second 5, a 1% change (increase or decrease) was made, then another change of 1% followed second 7. Changes of 1% followed seconds 9, 11, 13, and 15. During the remainder of the excerpts (approximately 6-8 seconds), no further changes in tempo were made.

Procedure

The four excerpts, two legato examples and two staccato examples, were each presented to listeners in three tempo modulation conditions: tempo increase, tempo decrease, and no change in tempo. This resulted in a total of 12 experimental stimuli. An additional example (a 20-second excerpt from Mozart's Serenade in B-flat, KV 361, movement 7) was added and presented at the beginning to all listeners as a practice excerpt to help ensure that the procedures were understood. The 12 experimental examples were presented on compact disc to listeners in four separate groups in different counterbalanced orders to distribute probable effects of presentation order. Copland and Hoist excerpts were presented in alternate order to prevent the ending tempo of a given example from influencing the initial perception of a subsequent example from the same piece. The following instructions were read to listeners:

This is a project regarding the perception of tempo. You will hear one practice example followed by twelve short music excerpts. For each excerpt indicate whether you hear the tempo increase, decrease or remain unchanged. Some of the changes may be subtle and others may be more obvious. Indicate the direction and amount of change that you perceive by circling the appropriate number. For example, if you hear a large increase in tempo, you would circle +4 or +5, or, if you perceive a subtle decrease in tempo, then you would circle -1 or -2. The examples are presented fairly quickly, so you won't have much time to think about your answer — we are interested in your immediate feeling about the tempo, not whether you are right or wrong. Just determine whether or not the tempo changes, mark the degree to which it changes, and then indicate your degree of liking or disliking for the performed tempo. Are there any questions? I will stop after the first example to see whether you have any additional questions.

Participants indicated responses on prepared forms that consisted of two 11-point rating scales for each stimulus. The first scale was designed to assess perceived changes in tempo, if any, and ranged from -5 (labeled as "extreme decrease in tempo") to +5 (labeled as "extreme increase in tempo"). The spaces between points 1 and 2 on the negative and positive sides of the midpoint were labeled as "subtle decreases" (increases) in tempo. The zero rating was labeled "no change." The second rating scale was designed to assess listener preferences for the tempo performances, not for the excerpt itself. This scale also included points ranging from -5 (labeled as "strong dislike"), through -1 (labeled as "mild dislike"), 0 ("no preference"), +1 ("mild like"), to +5 ("strong like").

RESULTS

We used separate repeated measures analyses of variance for listener judgments of tempo change and for tempo-change preferences. Both analyses included one between-subjects factor (the four orders of presentation)

and three within-subjects factors (the two pieces, the two articulation styles, and the three conditions of tempo change). We used an alpha level of .01 for rejection of null hypotheses in all statistical tests.

Perception of Tempo Modulations

There were no significant differences in main effects for presentation order or for the two pieces. Significant main effects were found for the variables of articulation style, $F(1,86) = 311.16, p < .001$, partial $\eta^2 = .78$, and direction of tempo change, $F(2,172) = 242.56, p < .001$, partial $\eta^2 = .74$. Table 2 shows that staccato stimuli ($M = +0.90$) were judged as increasing in tempo more than legato stimuli ($M = -0.73$). Table 2 shows also that tempo increases ($M = +1.38$) were perceived as increasing more than the no-change condition ($M = +0.05$) and tempo decreases ($M = -1.18$). All three means were significantly different from each other, $p < .001$, using the Bonferroni adjustment for multiple comparisons.

Significant interaction effects were found among several of the above factors. There was a two-way interaction between pieces and articulation styles, $F(1,86) = 15.27, p < .001$, partial $\eta^2 = .15$. Differences between legato and staccato styles were smaller for the Hoist excerpt (mean difference = 1.31) than for the Copland excerpt (mean difference = 1.94; see Table 2). Furthermore, there was a three-way interaction among pieces, styles, and order, $F(3,86) = 5.86, p < .01$, partial $\eta^2 = .17$. For the legato style examples, three of the order groups rated the two pieces approximately the same in tempo, and one group rated the Hoist example as increasing more in tempo ($M = 0.8$ higher). For the staccato examples, two of the groups rated the pieces about the same, whereas the other two groups rated the Hoist excerpt as increasing less in tempo ($M = 0.7$ lower) than the Copland example.

Perhaps most important, there was a significant two-way interaction between articulation style and the direction of tempo change, $F(2,172) = 34.32, p < .001$, partial $\eta^2 = .29$. Figure 1 presents an illustration of this interaction (means are shown also in Table 2). The figure shows that staccato articulation was consistently judged as increasing in tempo more than legato. Mean ratings for tempo increases and no change in tempo of staccato examples were above zero (which was labeled as "no change" on the rating scale).

Moreover, staccato examples, when increased in tempo, were judged as having greater increases in tempo than corresponding changes in legato examples to a larger extent than when no changes were made or when tempo was decreased. Perceived means in the no change and tempo decrease conditions of staccato articulations were judged about 1.25 points higher compared to corresponding legato means. In contrast, mean differences between the two articulation styles were nearly twice as large (2.37) in the tempo increase condition. None of the other interactions was statistically significant.

Preferences for Tempo Changes

Analysis of preference ratings for the stimuli showed no difference between the presentation orders, and a significant difference between the two pieces, $F(1,86) = 20.07, p < .001$, partial $\eta^2 = .19$ (significant main effect and 2-way interaction means are shown in Table 3). Listeners rated the Hoist examples ($M = +0.97$) higher than the Copland examples ($M = +0.45$). Ratings were significantly different between legato stimuli ($M = +0.92$) and staccato stimuli ($M = +0.50$), $F(1,86) = 12.63, p < .01$, partial $\eta^2 = .13$. Ratings for the direction of tempo modulation were also significantly different, $F(2,172) = 8.89, p < .01$, partial $\eta^2 = .09$.

According to the Bonferroni procedure ($p < .01$), listeners preferred the no-change versions ($M = +1.01$) to both the tempo increases ($M = +0.57$) and the tempo decreases ($M = +0.54$), which were not statistically different from each other.

Analysis showed two significant interactions in the preference ratings. There was a three-way interaction among pieces, styles, and presentation order, $F(3,86) = 4.55, p < .01$, partial $\eta^2 = .14$. The Hoist excerpts received higher preference ratings than the Copland excerpts for all the staccato examples and, with the exception of one of the four presentation orders, all the legato examples. Relevant to the second experimental question, there was a significant two-way interaction between articulation style and direction of tempo

modulation, $F(2,172) = 7.41, p < .01, \text{partial } \eta^2 = .08$. For the no-change and tempo-decrease examples, legato was rated only slightly higher in preference than staccato (the difference in means was approximately 0.15 on the 11-point scale). However, for the tempo-increase condition, legato was preferred over staccato to a much greater extent (mean difference = .97). In legato examples, there was little difference in preference ratings between the no-change and tempo-increase modulations (less than .02). In contrast, the staccato examples showed highest preference ratings for the no-change condition ($M = +0.94$) and tempo decreases ($M = +0.46$). Tempo increases of staccato examples resulted in the lowest preference ratings ($M = +0.09$).

DISCUSSION

Results indicated that articulation style and direction of modulation affected listener perception of tempo, and these two factors interacted significantly. All staccato stimuli were judged as increasing in tempo more than legato stimuli; however, in the examples with tempo increases, staccato excerpts were perceived as having greater increases than legato excerpts relative to the no-change and tempo-decrease examples. Even staccato examples with no tempo alterations were judged as increasing slightly in tempo. Furthermore, listeners preferred no change in tempo of staccato articulation compared to tempo increases or decreases. In contrast, preference ratings regarding legato articulation examples were higher for both the no-change and tempo-increase examples compared to tempo decreases.

The present investigation was purposefully designed to ascertain the interactions between and among the various changes. Results showed that there were obvious differences between articulation styles, as well as interactions with the direction of modulated change. Furthermore, there were interactions with the specific excerpt as well as with the order in which selections were heard. Although the purpose was not to compare differences between specific selections, listeners did perceive differences between them. Is there a unique contextual effect for every different excerpt regardless of tempo? It seems possible that style variations such as articulation have comparable or perhaps in some contexts larger effects than tempo itself. It is also possible that articulation style may have a distinct influence that is inextricably linked to tempo perception. More generally, just how do all of the aspects of music interpretation interact? Do they all interact together in one meaningful (for the listener) gestalt? Or are there separate effects for one or more of the aspects that are not interactive or cumulative? Results of the present study indicate that all aspects must be considered.

From an experimental-design perspective, it would seem desirable to control for, if not eliminate, effects of presentation order. It is indeed difficult to isolate effects of one or more independent variables in designs with cumulative learning effects or that use actual music performance examples. Therefore, it should not seem surprising to find order effects between stimuli in research that attempts to incorporate music within context. To the contrary, certain effects of order may be precisely what the composer intended in creating the sequence of the original composition (i.e., musical form), and it would seem more surprising not to find effects of order in any arrangement of contextual music examples.

Obviously, some slight or gradual variations of auditory events are such that many musicians are able to perceive them. Yet other music events are not perceived as clearly. In some previous investigations in which there were specific aspects manipulated, many musicians "heard" various differences in stimuli that were not present (Duke, Geringer, & Madsen, 1988; Geringer & Madsen, 1984; Madsen & Geringer, 2004, in press). For example, following very gradual and incremental changes in pitch during an entire movement, many listeners did not hear a pitch change but identified other aspects of the performance as changed, although those aspects had not been altered (Madsen & Geringer, 2004). Listeners were aware that something had changed, but they were not able to accurately distinguish the nature of the change. In the present study, for example, some listeners heard staccato examples as increasing in tempo, even when tempo did not modulate.

Possible specific applications for music teachers include the following: Ensemble directors should be aware of the propensity of listeners to prefer staccato passages that perceptibly do not rush or slow down, as opposed to legato sections that seem to be preferred with both steady tempo and slight gradual increases in tempo. Teachers and conductors may find value in carefully listening to recordings of rehearsals and performances, perhaps

using a metronome. Such analyses of tempo may reveal further differentiation between actual tempo performance and listener perceptions.

These results, which should be replicated, appear also to have general implications for music performance and teaching. Appropriate interpretation of music as well as discrimination in music listening appear to be important ongoing issues for music teachers and others concerned about authentic performance and meaningful listening. However, it can be argued that there are apparently relatively few aspects of acoustic events that contribute to perception and preferences. In addition to pitch and timbre there are only limited changes that contribute to the nuances desirable for sophisticated musical interpretations: loud/soft, short/long, and fast/slow. Yet myriad subtle effects of changing any of these aspects across time account for many different interpretations of the same music score. Furthermore, although there are many music terms that provide interpretive guidelines, questions still arise concerning the degree of perception that listeners are able to demonstrate when subtle changes are made. Additional research is necessary to address these and related questions pertaining to perception within music contexts.

Table 1: Music Excerpts Used for Legato and Staccato Stimuli

Legend for Chart:

A - Recording

B - Section

C - Articulation

D - Style Tempo

Copland Examples

A: Appalachian Spring, Telarc CD-80339

B: 19:17-19:40

C: Legato

D: $\text{\&quarternote;} = 87$

A: Conductor: Erick Kunzel, Cincinnati Pops Orchestra

B: 20:28-20:39 (repeated)

C: Staccato

D: $\text{\&quarternote;} = 94$

Holst Examples

A: First Suite in E-flat (Op. 28 No. 1),

B: 1:20-1:41

C: Legato

D: $\text{\&quarternote;} = 134$

Intermezzo, Telarc CD-80038

A: Conductor: Frederick Fennell,

Cleveland Symphonic Winds

B: 0:31-0:52

C: Staccato

D: $\text{\&quarternote;} = 135$

Table 2: Significant Main Effects and 2-Way Interactions for Tempo Ratings

Legend for Chart:

A - Independent Variable

B - Mean

C - Standard Deviation

Articulation Style

A: Legato

B: -0.73

C: 1.65

A: Staccato

B: +0.90

C: 1.81

Direction of Change

A: Increase

B: +1.38

C: 1.48

A: No Change

B: +0.05

C: 1.46

A: Decrease

B: -1.18

C: 2.07

Style and Direction Interaction

A: Legato Increase

B: +0.20

C: 1.05

A: Legato No Change

B: -0.59

C: 1.33

A: Legato Decrease

B: -1.79

C: 1.72

A: Staccato Increase

B: +2.57

C: 1.52

A: Staccato No Change

B: +0.69

C: 1.41

A: Staccato Decrease

B: -0.56

C: 1.73

Piece and Style Interaction

A: Copland Legato

B: -0.83

C: 1.56

A: Copland Staccato

B: +1.11

C: 1.92

A: Hoist Legato

B: -0.63

C: 1.43

A: Hoist Staccato

B: +0.68

C: 1.33

Table 3: Significant Main Effects and 2-way Interactions for Preference Ratings

Legend for Chart:

A - Independent Variable

B - Mean

C - Standard Deviation

Pieces

A: Holst

B: +0.97

C: 2.50

A: Copland

B: +0.45

C: 2.79

Articulation Style

A: Legato

B: +0.92

C: 2.47

A: Staccato

B: +0.50

C: 2.85

Direction of Change

A: Tempo Increase

B: +0.57

C: 2.68

A: No Change

B: +1.01

C: 2.15

A: Tempo Decrease

B: +0.54

C: 2.33

Style and Direction Interaction

A: Legato Increase

B: +1.06

C: 2.20

A: Legato No Change

B: +1.08

C: 1.93

A: Legato Decrease

B: +0.64

C: 2.29

A: Staccato Increase

B: +0.09

C: 2.95

A: Staccato No Change

B: +0.94

C: 2.18

A: Staccato Decrease

B: +0.46

C: 2.19

PHOTO (BLACK & WHITE): Figure 1. Interaction of articulation style and direction of tempo change.
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