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Effect of Tempo and Dynamics on the Perception of Emotion in Music

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Adults (N = 96) with little or no training in music heard one of four possible MIDI versions of each of four musical excerpts. The four versions of each excerpt included one with unvarying tempo and dynamics, one with variations in tempo only, one with variations in dynamics only, and one with variations in tempo and dynamics. Participants rated each excerpt on a 7-point scale for likeability and emotional expressiveness. Variations in dynamics resulted in higher ratings on both measures but variations in tempo had no such effect. In general, women rated the musical excerpts as more emotionally expressive and more likeable than did men. Finally, musical preferences were highly correlated with ratings of emotional expressiveness.

Introduction

According to Kivy (1980), music is “expressive of” emotions rather than expressing emotions directly. By this, he means that music can communicate emotional ideas without the necessity of composer, performer, or listener experiencing any emotion or the music having to symbolise particular emotions. For Kivy, a piece of music is “sad” in much the same way that a Saint Bernard’s face is sad; although we may recognise the quality of sadness in the dog’s face, we do not attribute sadness to the dog. Rather than expressing sadness, the dog’s face, like a passage of music, has aspects that are suggestive of human expressions of sadness. In fact, Kivy (1980) claims that we are predisposed to “animate” what we see and hear so that expressive aspects of visual art or music are interpreted in human emotional terms (e.g. sadness). Unlike Kivy (1980), however, who claims that music cannot arouse emotion in human listeners, Davies (1994) argues that, at times, listeners’ feelings may mirror those suggested by the music. Nevertheless, both scholars concur that the expressiveness of music is in the music itself rather than in the emotions of the composer or listener.

Kivy (1980) and Davies (1994) contend, further, that “natural” expressiveness in a musical piece is rooted in surface resemblances between aspects of the music – its dynamic character in particular – and aspects of human behaviour. In other words, analogies between aspects of the music (e.g. melody, rhythm, metre, tempo) and aspects of human action that are indicative of emotion (e.g. movement, gait, carriage) account for much of the natural expressiveness of music.

Although the foundations of expressiveness in music have a natural basis, expressive qualities may only be recognisable to listeners familiar with the cultural practices or styles reflected in particular musical pieces.
In contrast to natural expressiveness in music, other kinds of emotional expressiveness depend primarily on musical experience and knowledge. For example, patterns of tension (musical relations that are perceived as incomplete) and resolution (musical relations perceived as complete or pleasant) can also be related analogically to human experience and emotions (e.g. Blacking, 1979; Langer, 1953). Moreover, emotional expressiveness can result from fulfilment of or deviations from musical expectancies (Meyer, 1956). These kinds of musical expressiveness, which are rooted in stylistic conventions, are not the primary focus of the present investigation.

If natural expressive qualities are to be found in the surface appearance of music (i.e. the sounds themselves rather than symbolic aspects), then one would expect some consensus on interpretation, at least within a culture. Terwogt and Van Grinsven (1991), for example, found that listeners of different ages achieved reasonable agreement on expressions of happiness, anger, sadness, calmness and restlessness in music. Other researchers have attempted to link specific emotional interpretations to particular musical elements. In general, musical pieces with rapid tempo tend to be interpreted as happy and pleasant (Gundlach, 1935; Rigg, 1940; Scherer and Oshinsky, 1977; Swanwick, 1973; Watson, 1942; Wedin, 1972). Moreover, musical pieces with even-valued rhythms are perceived as sacred or serious compared to those with uneven-valued rhythms, which are interpreted as happy or playful (Gundlach, 1935; Hevner, 1936). Similarly, staccato articulation is perceived as lively or energetic, in contrast to legato articulation, which is seen as peaceful or gentle (Wedin, 1972).

Although the major mode is generally linked to happiness and the minor mode to sadness or anger (Crowder, 1985; Hevner, 1935; Scherer and Oshinsky, 1977), or to positive and negative narratives, respectively (Hill, Kamenetsky and Trehub, 1996), even for children (Hill et al., 1996; Kastner and Crowder, 1990), these emotional interpretations are believed to be highly conventionalized or arbitrary rather than having a natural basis (Davies, 1994; Kivy, 1980). In any case, factors such as tempo and rhythm may play a greater role in happy/sad distinctions than do the major and minor modes (Kratus, 1993). Finally, loud music tends to be perceived as animated or happy and soft music as delicate or peaceful (Gundlach, 1935; Watson, 1942).

Music theorists generally consider music of the baroque (1600–1750) and romantic (1820–1910) periods to differ substantially in terms of emotional expressiveness. In contrast to romantic music, which emphasises “the apparent domination of emotion over reason, of feeling and impulse over form and order” (Warrack, 1983, p. 1580), baroque music – especially that of the early to middle 18th century – has a “rationalist conception of the passions” (Tomlinson, 1986, p. 80). Nevertheless, these domains of “emotional” and “rational” music show considerable overlap (e.g. Schoenberg, 1950). What characteristics might contribute to the expressive distinctions between baroque and romantic music?

Two of the most salient musical features that distinguish baroque from romantic music are variations in tempo and dynamics (loudness/softness), both of which are related to the perception of motion in music and, by implication, emotion (Davies, 1994). Although tempo variations are common in romantic music (Randel, 1986), they are relatively uncommon in baroque music, tempo often remaining unchanged throughout a piece (Kirnberger, 1774/1982; Parrott, 1983). Moreover,
fluctuations of dynamics within musical pieces have increased steadily throughout the history of music (Parrott, 1983), such changes generally being less pronounced in baroque than in romantic music. Nevertheless, the contributions of tempo and loudness variations to emotional expressiveness in music have not been investigated to date. The principal purpose of the present investigation was to ascertain the effect of variations in tempo and dynamics on listeners’ perception of the emotional expressiveness of musical pieces. Our expectation was that greater variations in tempo and dynamics would result in higher ratings or emotional expressiveness.

The perception of emotion in a piece of music may also be affected by the gender of the listener. Indeed, there are claims of male/female differences in the interpretation of and responsiveness to music (Citron, 1993; McClary, 1991; Solie, 1993). In non-musical contexts, women are reported to have more intense emotional experiences (Allen and Haccoun, 1976; Johnson and Shulman, 1988), more frequent emotional experiences (Fabes and Martin, 1991), and to be more emotionally expressive both verbally (Johnson and Shulman, 1988) and gesturally (Brody and Hall, 1993). These differences may have their origin in socialisation practices. For example, girls are encouraged to express their feelings through words and facial expression, whereas boys are discouraged from comparable expressions of feeling (Saarni, 1993). A secondary goal of the present investigation was to document possible sex differences in the perception of musical expressiveness. On the basis of differences in the socialisation of emotion between males and females, we expected women to assign higher ratings of emotional expressiveness to particular pieces of music than men would. Finally, because familiarity has been linked to preference and to emotional interpretations (Gaver and Mandler, 1987; Kivy, 1980; Moreland and Zajonc, 1977), we expected listeners’ familiarity with the music to influence their judgements of its expressiveness.

Method

Participants

The participants (34 males, 62 females), who were drawn from the college community, were 18 to 68 years of age ($M = 27.1$ years). On average, they had 2–6 years of music lessons in childhood and little or no current involvement in music-making.

Materials

The stimuli were four musical excerpts, each consisting of one complete musical phrase: (1) measures 1–6 of Prelude 13 in F♯ major from Bach’s Well Tempered Clavier, Book 1 (designated Bach Prelude), (2) measures 25–32 of Bach’s Aria to the Goldberg Variations (Bach Aria), (3) measures 1–16 of Frederic Chopin’s Nocturne in E♭ major (Chopin Nocturne), and (4) measures 1–12 of Franz Liszt’s Liebestraum, No. 3 (Liszt Liebestraum). All four pieces were written for keyboard and were in the major mode. Texture was similar across two of the selections, the Bach Prelude and Liszt Liebestraum being arpeggiated, in contrast to the Bach Aria and Chopin Nocturne, with their melody and accompaniment texture. Metre was similar across pairs of pieces, the Bach Prelude and Liszt Liebestraum being compound duple metres (larger metrical units parsed in groups of two, each beat divided into three sub-beats), in contrast to the Bach Aria and the Chopin Nocturne,
with their simple triple metres (larger metrical units parsed in groups of three, each beat divided into two sub-beats).

The four excerpts, each approximately 30 s in duration, were sequenced by means of Performer software on a Macintosh Quadra 950 and Korg 01/WFD Music Work Station using its pre-programmed Piano (8') voice. Each excerpt was quantised (*i.e.* durations of each eighth note, quarter note, and so on equalised) and its loudness set at a constant level, resulting in a base version with unvarying tempo and dynamics. Expressive versions were generated by a professional musician who added variations in tempo and dynamics to the base version (by means of the sequencing software) to create a performance deemed suitable for a musically unsophisticated audience. Two other musicians listened to the expressive versions and suggested further changes. The final expressive versions (*i.e.* those with variations in tempo and dynamics) were deemed appropriate by all three musicians. Changes in tempo or dynamics were removed, as necessary, for the versions with no variations in one of these dimensions. The stimulus set consisted of one version of each excerpt with unvarying tempo and dynamics, a second with variations in tempo (but no variations in dynamics), a third with variations in dynamics (but no variations in tempo), and the fourth with variations in tempo and dynamics (the latter achieved by consensus of the three musicians). The Bach Prelude with variations in tempo and dynamics is shown in Figure 1. The 16 musical stimuli (4 versions of each excerpt) were arranged in a Latin square design (see Table 1) so that every order included each of the four musical excerpts in one of four combinations of different versions. Although this design precluded the assessment of interactions between changes in dynamics and tempo, it had the advantage of preventing listeners from hearing more than one version of any musical piece. Each order of stimuli was recorded in stereo on chromium dioxide tapes using a Yamaha MT1X multitrack cassette recorder with a constant recording level.

**Table 1**

Four orders of music pieces and conditions (variations in tempo and dynamics).

<table>
<thead>
<tr>
<th>Excerpt</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bach Prelude</td>
<td>none</td>
<td>tempo and dynamics</td>
<td>tempo</td>
<td>dynamics</td>
</tr>
<tr>
<td>Bach Aria</td>
<td>tempo and dynamics</td>
<td>tempo</td>
<td>dynamics</td>
<td>none</td>
</tr>
<tr>
<td>Chopin Nocturne</td>
<td>tempo</td>
<td>dynamics</td>
<td>none</td>
<td>tempo and dynamics</td>
</tr>
<tr>
<td>Liszt Liebestraum</td>
<td>dynamics</td>
<td>none</td>
<td>tempo and dynamics</td>
<td>tempo</td>
</tr>
</tbody>
</table>
A. Bach Prelude with manipulations of tempo and dynamics presented in standard musical notation.

B. Schematic representation of variations in tempo and dynamics used in revised versions of the Bach Prelude. Horizontal lines indicate basal levels of tempo and dynamics. Jagged lines indicate increasing (rising) and decreasing (falling) levels of these two features.
Procedure

Listeners were tested individually (Craig JS 8222 Portable Tape Player, Koss WM/60 Stereo Headphones) in the laboratory or in groups during a regularly scheduled introductory music appreciation class (Panasonic Portable Stereo Component CD System RX DT680). They were assigned to one of the four test orders, as shown in Table 1. Class participants were subdivided into four groups, each receiving a different test order. Because participants had little training or involvement in music, we provided a brief written orientation to the task in the form of a few statements about music and emotion.

Music is an integral part of the lives of many people. Many of us listen to music for pleasure, and we hear music in a variety of situations and places. Music sometimes alters our mood, making us feel happy or sad; it also arouses associations or thoughts about more specific events, places and objects. We would like you to participate in a music appreciation experiment. You will listen to several musical pieces and will be asked to answer a few questions about each.

Listeners were subsequently instructed to listen carefully and to rate, on a 7-point scale, (1) the emotional expressiveness of each excerpt, (2) how much they liked it, (3) the degree of variation in tempo (manipulation check), (4) the degree of variation in dynamics (manipulation check), and (5) the excerpt’s familiarity.

Results

Separate analyses of variance (ANOVAs), with sex (male, female), condition (tempo and dynamics constant, variations in tempo only, variations in dynamics only, variations in tempo and dynamics), and musical piece (Bach Prelude, Bach Aria, Chopin Nocturne, Liszt Liebestraum) as factors, were conducted for each dependent measure. Because unique features of each musical piece could influence ratings of emotional expression and likeability, musical piece was included in the analyses to allow for the separation of such effects from those attributable to changes in tempo and dynamics. Two of the pieces were from the baroque period and two from the romantic period, but these musical selections cannot be considered to represent all features of those musical styles. Thus, musical period was not used as a factor. Because of the Latin-square design, moreover, the only interactions to be considered were those involving the sole between-subjects factor, sex of listener.

An ANOVA designed to verify manipulations of dynamics revealed a significant main effect of condition, $F(3,374) = 123.81, p < .0001$. As shown in Table 2, ratings of changes in dynamics were highest for excerpts in which tempo and dynamics both varied, followed closely by excerpts with variations in dynamics only, those with variations in tempo only, and, finally, no variations in tempo or dynamics. Similarly, an ANOVA to verify manipulations of tempo revealed a significant main effect of condition, $F(3,374) = 46.28, p < .0001$. As shown in Table 3, ratings of tempo changes were highest for excerpts in which both dynamics and tempo varied, followed by those in which only tempo varied, only dynamics varied, and, finally, neither tempo nor dynamics varied. In other words, listeners perceived the presence or absence of variations in tempo and dynamics.
TABLE 2
Means and standard deviations for ratings of variations in dynamics.

<table>
<thead>
<tr>
<th>Condition</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variations in tempo and dynamics</td>
<td>5.32</td>
<td>1.48</td>
</tr>
<tr>
<td>Variations in dynamics only</td>
<td>5.31</td>
<td>1.33</td>
</tr>
<tr>
<td>Variations in tempo only</td>
<td>3.16*</td>
<td>1.43</td>
</tr>
<tr>
<td>No variations in tempo or dynamics</td>
<td>2.25*</td>
<td>1.32</td>
</tr>
</tbody>
</table>

*Fisher’s LSD indicates a significant difference from the next highest level, *p < .0001.

TABLE 3
Means and standard deviations for ratings of variations in tempo.

<table>
<thead>
<tr>
<th>Condition</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variations in tempo and dynamics</td>
<td>4.55</td>
<td>1.44</td>
</tr>
<tr>
<td>Variations in tempo only</td>
<td>4.23</td>
<td>1.55</td>
</tr>
<tr>
<td>Variations in dynamics only</td>
<td>3.37*</td>
<td>1.84</td>
</tr>
<tr>
<td>No variations in tempo or dynamics</td>
<td>2.25*</td>
<td>1.33</td>
</tr>
</tbody>
</table>

*Fisher’s LSD indicates a significant difference from the next highest level, *p < .0001.

TABLE 4
ANOVA for emotional expression.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1</td>
<td>4.70*</td>
</tr>
<tr>
<td>Musical Piece</td>
<td>3</td>
<td>8.30***</td>
</tr>
<tr>
<td>Condition</td>
<td>3</td>
<td>15.70***</td>
</tr>
<tr>
<td>Sex by Musical Piece</td>
<td>3</td>
<td>3.97**</td>
</tr>
<tr>
<td>Sex by Condition</td>
<td>3</td>
<td>0.505</td>
</tr>
<tr>
<td>Error</td>
<td>374</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05   **p < .01   ***p < .0001

An ANOVA on emotional expressiveness ratings revealed significant effects of sex of listener and condition (see Table 4). Emotional expressiveness ratings were highest when both dynamics and tempo varied, next highest when only dynamics varied, next when only tempo varied, and, finally, when neither dynamics nor tempo varied (see Table 5). Fisher’s LSD revealed no differences in expressiveness ratings between excerpts with variations in tempo and those with no variations in tempo or dynamics. There was also a significant effect of sex, with female listeners assigning higher expressiveness ratings (M = 4.60) than male listeners (M = 4.29).
An ANOVA on likeability revealed significant effects of sex of listener and condition (see Table 6). Women assigned higher ratings of likeability $M = 4.48$ than did men ($M = 4.05$). Likeability ratings were highest for excerpts with variations in tempo and dynamics, followed by those with variations in dynamics only, tempo only, and neither tempo nor dynamics (see Table 7). Fisher’s LSD revealed that ratings of excerpts with variations in tempo did not differ from ratings of excerpts.

**Table 5**

Means and standard deviations for ratings of emotional expression for each condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variations in tempo and dynamics</td>
<td>5.01</td>
<td>1.38</td>
</tr>
<tr>
<td>Variations in dynamics only</td>
<td>4.91</td>
<td>1.30</td>
</tr>
<tr>
<td>Variations in tempo only</td>
<td>4.13*</td>
<td>1.41</td>
</tr>
<tr>
<td>No variations in tempo or dynamics</td>
<td>3.91</td>
<td>1.61</td>
</tr>
</tbody>
</table>

*Fisher’s LSD indicates a significant difference from the next highest level, $p < .0001$.

**Table 6**

ANOVA for likeability.

<table>
<thead>
<tr>
<th>Source</th>
<th>$df$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1</td>
<td>7.28*</td>
</tr>
<tr>
<td>Musical Piece</td>
<td>3</td>
<td>8.23**</td>
</tr>
<tr>
<td>Condition</td>
<td>3</td>
<td>7.45**</td>
</tr>
<tr>
<td>Sex by Musical Piece</td>
<td>3</td>
<td>1.74</td>
</tr>
<tr>
<td>Sex by Condition</td>
<td>3</td>
<td>0.59</td>
</tr>
<tr>
<td>Error</td>
<td>374</td>
<td></td>
</tr>
</tbody>
</table>

*$p < .01$  **$p < .0001$

**Table 7**

Means and standard deviations for ratings of likeability for each condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variations in tempo and dynamics</td>
<td>4.76</td>
<td>1.41</td>
</tr>
<tr>
<td>Variations in dynamics only</td>
<td>4.59</td>
<td>1.35</td>
</tr>
<tr>
<td>Variations in tempo only</td>
<td>4.01*</td>
<td>1.57</td>
</tr>
<tr>
<td>No variations in tempo or dynamics</td>
<td>3.96</td>
<td>1.65</td>
</tr>
</tbody>
</table>

*Fisher’s LSD indicates a significant difference from the next highest level, $p < .0001$. 

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with no variations in tempo or dynamics. Furthermore, excerpts with variations in both tempo and dynamics were no more likeable than those with dynamics variations alone.

An ANOVA on familiarity ratings revealed a significant effect of sex of listener, $F(1,374) = 14.27, p < .0005$. Women assigned higher familiarity ratings ($M = 3.00$) than did men ($M = 2.22$). Finally, tests of simple associations revealed significant correlations between emotional expression and familiarity, $r = 0.35$, $p < 0.0001$, and between emotional expression and liking, $r = 0.74$, $p < 0.0001$. Due to the significant association between familiarity and liking, $r = 0.41$, $p < 0.0001$, however, familiarity did not make a significant contribution to predicting emotional expression when effects of preference were held constant.

**Discussion**

These results shed light on the three overall goals of the present investigation. Our expectation that variability in tempo and dynamics would be related to ratings of expressiveness was only partially confirmed. Despite the fact that variations in tempo were readily detected, as were variations in dynamics, only the latter had measurable effects on emotional expressiveness. In other words, musical pieces with variations in tempo and dynamics yielded expressiveness ratings comparable to those with variations in dynamics alone. In view of the common occurrence of simultaneous variations in tempo and dynamics (e.g. accelerations of tempo accompanied by increased loudness, and decelerations of tempo by decreased loudness) in music, differential effects associated with tempo and dynamics are surprising. Perhaps listeners need formal training in music or comparable guidance to acquire the expressive conventions of their musical culture. If so, why did they link changes in dynamics but not those in tempo to emotional expressiveness?

Studies of emotional expressiveness in spoken communications indicate that variability in fundamental frequency and intensity is associated with greater emotionality (Bachorowski and Owren, 1995; Murray and Arnott, 1993; Pittam and Scherer, 1986). Although particular tempi have been linked to specific emotions, such as fast tempo with joy and fear (Scherer, 1986) and slow tempo with tenderness and sadness (Davitz, 1964; Fonagy and Magdics, 1963), there is little indication of tempo variability within an utterance being linked to arousal or emotion. In musical contexts, then, variations in dynamics, unlike those in tempo, might be interpretable by extrapolation from speech contexts, that is, in terms of expressive conventions in language. It is possible, moreover, that changes in dynamics are not arbitrary expressive devices but are "naturally" expressive and, therefore, universally interpretable. This contention, although speculative, is amenable to empirical evaluation.

Our expectations of sex differences in emotional interpretations of music was also confirmed, indicating that such differences are not limited to particular musical pieces or response modes. In general, women found the music to be more emotionally expressive and more likeable than men did. These findings are consistent with women's greater emotional expressiveness in non-musical domains (Allen and Haccoun, 1976; Johnson and Shulmann, 1988), their greater inclination to assign positive evaluations compared to men (Taylor and Hinds, 1985; Warr, 1971), and their superiority in identifying affect from non-verbal cues (Hall, 1978;
1984). The absence of sex differences in rating (as opposed to interpreting) variations in tempo and dynamics rules out the possibility that sex differences in expressiveness ratings were attributable to differential detectability of relevant stimulus changes or to differential use of rating scales. Instead, it would appear that women and men differed in the interpretations assigned to musical performance differences. Thus, women seem to be superior to men at decoding expressive cues in music, as they are at decoding expressive facial and vocal cues (Hall, 1978; 1984). Obviously, it is impossible to disentangle effects attributable to differential socialisation from those originating in more basic biological differences. It is clear, however, that socialised gender roles make a substantial contribution to emotional expression (Brody and Hall, 1993). For example, “feminine” individuals display more skill at expressing emotion by means of face and voice than do less feminine individuals (Zuckerman, DeFrank, Spiegel and Larrance, 1982). Moreover, peers and family seem to encourage emotional expressiveness in girls while subtly discouraging it in boys (Brody and Hall, 1993).

Although we found that the familiarity of musical pieces was correlated with preference, as is the case for non-musical stimuli (Gaver and Mandler, 1987; Moreland and Zajonc, 1977; Zajonc, 1968; but see Heyduk, 1975), familiarity in itself cannot be responsible for the differential effects of changes of tempo and dynamics on emotional expressiveness. Tempo and dynamics were manipulated across all musical pieces, so that the expressive consequences of changes in tempo and dynamics were necessarily free of familiarity effects. Nevertheless, ratings of likeability were highly correlated with ratings of emotional expressiveness, indicating that manipulations that gave rise to heightened expressiveness also resulted in heightened preference. Sex differences in preference may stem, in part, from the somewhat greater familiarity of the musical pieces to women compared to men (although the pieces were relatively unfamiliar to both) and, in part, from patterns of socialisation that make emotionally expressive events more palatable to women than to men (Saarni, 1993).

In short, we established that variations in dynamics but not tempo influence listeners’ perception of emotion in music as well as their musical preferences. We confirmed, moreover, that female listeners, in general, interpret music as more emotionally expressive than do their male counterparts.

References


