Can dance reflect the structural and expressive qualities of music?
A perceptual experiment on Balanchine's choreography of Mozart's Divertimento No. 15

CAROL L. KRUMHANSL AND DIANA LYNN SCHENCK
Cornell University

ABSTRACT
A perceptual experiment investigated the structural and expressive mappings between music and dance. The stimulus materials were based on the Minuetto from W. A. Mozart's Divertimento No. 15 choreographed by George Balanchine. Participants were assigned to one of three conditions: Music Only, Dance Only, and Both Music and Dance. They performed four on-line tasks: indicating the occurrence of section ends and new ideas, and judging the amount of tension and emotion expressed. Each of the tasks showed strong similarity across the three conditions, including the Music Only and the Dance Only conditions which contained none of the same stimulus materials. Analysis of the music and dance uncovered a large variety of elements that define mappings between music and dance. These operate on different hierarchical levels and suggest non-accidental relationships between music and bodily movement. The Both Music and Dance condition could be predicted as a combination of the Music Only and Dance Only conditions, with a stronger contribution of the former. The findings for this excerpt suggest an additive, non-interactive relationship between the music and dance. All three conditions exhibited the same temporal pattern among the tasks. New ideas were introduced at section beginnings when levels of tension and emotion expressed were low. These levels tended to increase within sections, reaching a peak just before section ends. These results suggest that a general schema of temporal organization operates in both music and dance. Finally, the three conditions produced very similar judgments of the type of emotional response, supporting the idea that both music and dance can engage similar representations of emotions.
MAPPINGS OF STRUCTURE AND EXPRESSION BETWEEN MUSIC AND DANCE

The relationship between music and bodily movement has been approached from a variety of directions. Systems for representing music by bodily movement have been described by Truslit (1938; see Repp, 1993) and Clynes and Nettheim (1982). These proposals are based on the premise that the two modalities can potentially communicate similar expressive qualities. In support of this, Francès and Bruchon-Schweitzer (1982) found actors could successfully convey musical expression in videotaped recordings of their movements. Gabrielsson (1973 a, b; 1988; 1993) has stressed the connection between motional and emotional aspects of musical rhythms. Sundberg and collaborators have proposed two specific relationships between music and bodily movement: between musical tension and vocal effort (Sundberg, 1987), and between timing patterns in musical rubato and the decrease of footstep rate of a runner coming to a stop (Kronman & Sundberg, 1987; Sundberg, Friberg, & Frydén, 1991). Davidson (1993) reported perceptual experiments investigating whether auditory and visual modalities convey similar information about expressiveness in musical performances. Observers reliably perceived the degree of expressiveness whether they only heard the music, or only saw point-light displays (Johansson, 1973) of the performers' motions, or both heard the music and saw the visual display.

Dance is another domain in which to study the relationships between music and bodily movement. A number of considerations suggest the potential for rather close mappings between music and dance. Both consist of temporally extended sequences that subdivide into structured units (e.g., Lasher, 1981; Krumhansl, 1996). The beginnings of the units are marked by stable, preparatory elements, followed by unstable elements that resolve with pattern completion. In one of the few available psychological studies of dance, Lasher (1981) demonstrated the existence of a cognitive schema for such units. Observers recognized preparatory-completing segments more accurately than completing-preparatory segments. Moreover, they falsely recognized preparatory-completing segments that had not in fact appeared in the dance sequence. These results parallel those showing that unstable elements in music are poorly recognized and are frequently confused with more stable elements (e.g., for tones, Krumhansl, 1979; for harmonies, Krumhansl, Bharucha, & Castellano, 1982; Bharucha & Krumhansl, 1983; for melodic sequences, Cuddy, Cohen, & Miller, 1979; Bharucha, 1984; for rhythm and meter, Bharucha & Pryor, 1986; Palmer & Krumhansl, 1990). In addition, as described in more detail later, parallels between music and dance may be found in tempo, dynamics, texture, contour, and the structuring of larger-scale hierarchically organized formal units.

Despite the lack of empirical studies, the descriptive dance literature contains extensive discussion of the different kinds of relationships that may exist between music and dance. Several sources emphasize the close relationship between music and dance, with music not only providing the rhythmic basis for the dance but also
Can dance reflect the structural and expressive qualities of music?
CAROL L. KRUMHANSI AND DIANA LYNN SCHENCK

...playing an important role in the expression of emotion and style. For example, Wiley (1985) states that dance music may reflect and supplement the "mental movements" of the dancer, clarifying for the audience what the dancer cannot express in steps alone. Dance music works with the dance movement to convey meaning and emotion, but should not be in the forefront, obscuring the dance or distracting the audience from the movement of the dancers. "Music is only an accomplice. Music must excite, support, and guide the movements of the choreographic artists...not at all attracting exclusive attention to itself." (Wiley, 1985, p. 8) Teck (1990) also stresses the role of music as the foundation and frame for the dance. To her, the interaction between movement and sound is the most fundamental element of dance. The dance does not mimic the music — there is not a particular part of the music for every gesture and step — but the basic "kinetic feel" or "energy shape" of the music is expressed by the dance. The dancers' movements are suggested by the motivic material in the music; in this way, the dance draws on the music for its style, rhythm, and expressive qualities. The choreographer uses the music not only for its rhythmic pulse, but also as a source of emotional and structural ideas. Thus, elements of the music are often observed in the dance.

Hodgins (1992) suggests two main categories for these "choreomusical" parallels, extrinsic relationships and intrinsic relationships. Extrinsic relationships involve narrative or cultural context, knowledge of the plot, and the audience's presupposed knowledge of the dance or music. Intrinsic relationships, on the other hand, are more easily observable and do not depend on context. Intrinsic relationships fall into six main categories: rhythmic (accent, meter, sounds produced by the dancers), dynamic (volume of musical gesture versus volume of choreographical gesture), textural (number of instruments or performers, homophony versus polyphony, counterpoint), structural (corresponding motives or figures, phrases, structures), qualitative (choreomusical parallels of tessitura, timbre, articulation, dissonance or consonance), and mimetic (choreography imitates a particular sound in the music). Specific examples of such intrinsic relationships are described later in this article. Choreographers may incorporate many of these choreomusical parallels when creating their dances, or very few, or may intentionally create oppositions between the dance and music.

This exploratory study examines the extent to which observers are sensitive to mappings between music and dance when correspondences exist. For this purpose, we selected a piece that intuitively appeared to contain many choreomusical parallels, a dance choreographed by George Balanchine to Mozart's Divertimento No. 15 in Bb major (KV 287). Balanchine is noted for being especially attentive to the music. Trained as a musician, he uses the structural and expressive elements of his carefully chosen scores as a basis for the movement in the dance. Once quoted as stating, "Music puts a time corset on the dance" (Jordan, 1993). Balanchine stressed time and metrical pulse, which he believed provide a structure required for sustained movement of the dance. In performance, the music provides the basic plot, while
the dancers flesh out and develop the finer elements of the story. Concerning this attention to musical phrasing, one Balanchine biographer commented, "If composers are the masters of time, then Balanchine is the master of visual realization of that time in human terms." (McDonagh, 1983, p. 2) A dancer trained by Balanchine, Moira Shearer, also observed his consistent use of musical ideas in his choreography: "He merged modern and classical movement in a melange of his own; he used stillness, then dramatic physical pyrotechnics, exactly as the music suggested." (Shearer, 1986, p. 128) Hodgins (1992) described Balanchine's choreography as a "dialogue with the score" (p. 20) rather than an outright imitation. Balanchine rarely used direct correspondences between steps and individual instruments or parts of the piece, but instead carried through the dance the essence of the score. After collaborating with him on the choreographed piece, Movements for Piano and Orchestra, Igor Stravinsky marveled, "To see Balanchine's choreography of the Movements is to hear the music with ones eyes...The choreography emphasizes relationships of which I had hardly been aware...and the performance was like a tour of a building for which I had drawn the plans but never explored the result." (Jordan, 1993, p. 297)

Balanchine's attention to musical ideas is evident in his use of rhythm and musical pulse, which form the foundation of his choreography. Unlike his contemporaries, Balanchine did not permit the purposeful slowing of the music to allow dancers time for preparations before launching into difficult choreographical sequences or moves. Balanchine refused to sacrifice the music for the sake of the dance. To remain rhythmically accurate and on the beat, Balanchine's dancers learned to get into positions quickly and accurately and perform movements with little or no preparations (McDonagh, 1983). The structure of the dance follows the hierarchical structure of the music. For example, in the choreography of Mozart's Divertimento No. 15 each movement follows the two- to four- to eight-measure hierarchy of the music. Balanchine's footwork provides the primary rhythm for the dance, following the metrical structure of the music, but often counterpointed against the music to create variety and rhythmic tension (Jordan, 1993). In Balanchine's choreography, the general level of tension usually builds up gradually throughout the piece, and is increased significantly in the last eight to sixteen bars by increasing tempo, crisscrossing groups of dancers, increasing number and height of jumps, and counterpointing dancer's variations against each other (Jordan, 1993). By playing his dance steps off against the elements of the score, Balanchine creates a high degree of choreomusical parallels.

The stimulus piece used here, the Minuetto of the Divertimento No. 15, is an excellent example of Balanchine's choreographical style. His faithfulness to form and rhythm is evident in the strict sense of meter established in the steps, and the pairings of the dancers, which is a reference to the original minuet dance. Minuet dance, which originated in the court of Louis XIV in the mid-17th century, is performed in couples at a moderate pace. The minuet dance consists largely of the ceremonial
bow, the couple’s separation to the opposite ends of the room, the performance of the two-measure-long basic step, and continuous passing and re-passing as the couple approaches and withdraws from each other (Guthrie, 1982). Besides these basic steps, there are ornamental steps that are added according to the skill of the performers, including turns, jumps, and kicks. The minuet’s style resembles that of classical ballet, with its partnering, ballet-like steps, pointed toes, and arm positions, and its performance on demi-pointe. In his choreography of the Minueto, Balanchine incorporated quite a few of these elements, including the pairings of dancers, the duets during the Trio section, and the intermittent taking and letting go of hands. Another choreographical element, the bow-like pas de chat steps, which are executed at the beginnings and ends of some sections (most noticeably the duet sections), is reminiscent of the ceremonial bows made by the 17th century court dancers as they stepped to and away from the dance floor.

The music itself is in classic minuet form, with a rounded binary structure consisting of a repeated A section, a repeated B section, or Trio, and a return to the A section at the end, which is traditionally performed without repeats (Bennett, 1980; Randel, 1978). This rounded binary minuet form originated in the tradition of combining two contrasting, but thematically and harmonically related minuets for dancing purposes. Just as the second minuet contrasts with the first minuet, the Trio section contrasts with the A section (key of B-flat-major) by beginning in its relative minor, G-minor. There is also a temporary return to the tonic (B-flat) in the second Trio section, a common characteristic of minuet movements. The minuet is the traditional form of the third movement of symphonies and small ensemble works, in which it provides a contrast between the slower second movement and the allegro finale of the fourth movement. The tempo and style of the piece chosen for the stimulus are consistent with the performance of similar works, and therefore is a work that is quite representative of the minuet style.

In the experiment, the participants either heard the music (Music Only condition), saw the dance (Dance Only condition), or heard the music and saw the dance (Both Music and Dance condition). They performed four on-line tasks on successive presentations of the stimulus materials. Three of the tasks were used in a previous study (Krumhansl, 1996): judgments of section ends, amount of tension, and new ideas. The task of judging section ends is similar to that used by Imberty (1981), Clarke and Krumhansl (1990), and Deliège and El Ahmadi (1990). Continuous measurements of perceived tension have been taken previously by Nielsen (1983) and Madson and Fredrickson (1993; Fredrickson, 1995). The fourth task, the task of judging the amount of emotion expressed, is patterned after Davidson (1993), except that it is judged continuously during the piece. In the beginning of the experiment, the participants heard or saw the selection once to gain familiarity, and then performed the four tasks in a fixed order. The order of tasks was chosen to separate the two discrete judgments (section ends and new ideas) from one another, and to separate the two continuous judgments (tension and amount of
emotion expressed) from one another. Judgments of section ends were made 
because the previous study (Krumhansl, 1996) found these responses changed little 
with increased experience with the piece. Finally, at the end of the experiment par-
ticipants judged the emotional qualities so that we could determine the degree of 
similarity in the emotion expressed by the stimulus materials in the different condi-
tions.

Of primary interest are the comparisons across the three conditions. If choreo-
musical parallels are psychologically real, then the data from the Music Only and the 
Dance Only conditions should correlate even though they contain none of the same 
stimulus materials. If correlations are found, the music and dance can then be ana-
alyzed to determine the elements that induce similar cognitive and affective repre-
sentations of this piece. The experiment also examines the combined effect of the 
music and dance. Specifically, the data from the Both Music and Dance condition 
can be tested to see whether it can be predicted by the Music Only and Dance Only 
conditions. If so, then the relative weights can be assessed, as well as possible inter-
actions between the two components. Of secondary interest are the temporal pat-
terns that obtain among the four tasks. Krumhansl (1996) found, for the first move-
ment of Mozart’s Piano Sonata in Eb major (K 282), consistent relationships among 
judgments of section ends, tension, and new ideas. New ideas were introduced at the 
beginning of sections when judged tension was low. Tension tended to increase 
throughout sections, reaching a peak just before section ends that co-occurred 
occurred with drops in tension. These temporal patterns are of interest because of 
possible parallels with spoken discourse (Chafe, 1994). The present study examines 
whether this temporal pattern can also be found in dance.

METHOD

- **Participants.** Twenty-seven Cornell University students participated in the exper-
iment that lasted approximately one hour. They received credit toward psychology 
courses. They varied widely in their previous music and dance experience. On aver-
age they had taken 9.2 years of music lessons and 7.3 years of dance lessons, and had 
participated for 10.4 years in musical activities and 3.5 years in dance activities. 
Nine participants were randomly assigned to each of three conditions: Music Only, 
Dance Only, and Both Music and Dance. By chance, the participants in the Both 
Music and Dance condition had the highest average music and dance experience, 
and the participants in the Dance Only condition had the lowest average music and 
dance experience.

- **Apparatus.** The videotape was played by a SONY SLV-940HF VHS videotape 
player and displayed over a Panasonic CT-1920M Color Video Monitor. The 
responses were made using the two foot pedals of a Yamaha KX88 keyboard. One
foot pedal, the foot switch, codes off/on as 0/127. The other foot pedal, the foot controller, codes the position of the pedal continuously in the range 0 to 127. The position of the foot pedal was recorded every 250 msec by a Macintosh IIix computer using the MAX software.

- **Stimulus Materials.** The stimulus materials were taken from a videotape filmed by Virginia Brooks at the School of American Ballet, 23rd Annual Workshop, 1987. The filming was done with a single camera at a fixed location, without zooms or cuts. As such, it provided a reproduction of the dance that is minimally affected by film editing. The choreographer was George Balanchine, and the music was W. A. Mozart's *Divertimento* No. 15 in Bb major (KV 287) played by the Philharmonia (with members of the Juilliard Orchestra). Only the *Minuetto* (the third movement) was used in the experiment. A time stamp indicating the elapsed minutes and seconds was superimposed on the upper right-hand corner of the screen. In the Music Only condition, the screen was covered by a sheet of cardboard; in the Dance Only condition, the volume was turned off. When played, the music was sounded at a comfortable loudness level (approximately 70 dBA). The duration of the tape was 3 minutes 35 seconds.

- **Procedure.** Participants, who were run individually, were told that this was an experiment about the relationship between music and dance. They were told to which condition they had been assigned, and the four tasks were described briefly. They then saw and/or heard the videotape once through so that they could become familiar with it. Then, each of the four tasks was described in detail and performed. For the first task, they were told to press the foot switch "whenever you think a section has ended." For the second task, they were told to adjust the position of the foot controller "to indicate amount of tension." For the third task, they were told to press the foot switch "whenever you think a new idea is introduced or reintroduced." For the fourth task, they were told to adjust the foot controller "to indicate the amount of emotion expressed." They were instructed to start with the foot pedal in the neutral (0) position in all tasks, and to use the full range of the foot controller in the second and fourth tasks.

After completing the four tasks, they filled out a questionnaire asking about the emotions they felt during the videotape on rating scales ranging from 0 (Not at all) to 8 (Very Much). The emotion scales (based on previous research by R. W. Levenson, personal communication, 1995; see for example, Gross & Levenson, 1993) were: Afraid, Amused, Angry, Anxious, Contemptuous, Contented, Disgusted, Embarrassed, Happy, Interested, Relieved, Sad, and Surprised. They also used these scales to rate overall Pleasantness and Intensity and their Familiarity with the music and/or the dance before the experiment. Three of the participants reported being slightly familiar with the music; one very familiar with it. They also were asked to report any thoughts they had during the videotape. Finally, they completed a questionnaire about their music and dance backgrounds.
RESULTS

Before presenting the results, we describe the ways in which the data were preprocessed. Two of the tasks, judging section ends and new musical ideas, were made on a discrete scale. To compile a smooth cumulative record that took account of the slightly different response lags of these judgments, a moving average over 2.250 seconds (approximately 5 beats) was computed. This produces a smooth cumulative record of the responses and is graphed as the percentage of participants responding within each window of time. The other two tasks, judging the amount of tension and emotion expressed, were made on a continuous response scale. Participants were instructed to use the entire range of the response scale. Nonetheless, some of the participants used a narrower range than others. To weight each participant equally, each subject's data were normalized before averaging. The values plotted in the graphs are the averages adjusted to the range from 0 to 1. The vertical bars in each graph indicate the sections corresponding to the measure numbers shown below. Analyses of the three separate conditions are presented first, followed by analyses comparing the conditions.

- **Music Only Condition.** Figure 1 shows the data from the Music Only condition. The top graph shows the judgments of section ends. As would be expected, these co-occurred with the ends of the musical sections and their repetitions. Somewhat fewer responses of section ends were found in the middle of the sections in measures 9 - 28, 29 - 44, and 45 - 64. These data indicate the musical segmentation was very clear to the participants. The second graph in Figure 1 shows the judgments of new ideas. As can be seen, these occurred at the beginning of each musical section. They also occurred in the middle of the sections in measures 9 - 28, 29 - 44, and 45 - 64. The section end judgments were followed soon thereafter by new ideas; the values in these graphs correlated strongly, r(df = 837) = .663, p < .0001.

  The third and fourth graphs show the judgments of tension and emotion expressed; these correlated strongly, r(df = 851) = .794, p < .0001. Both measures tended to increase after new ideas were introduced and decrease at section ends. As a consequence, the tension judgments correlated negatively with both section ends and new musical ideas, r(df = 837) = -.336 and -.325, respectively. Emotion expressed also correlated negatively with both section ends and new musical ideas, r(df = 837) = -.319 and -.266, respectively; all correlations were significant at p < .0001.

- **Dance Only Condition.** Figure 2 shows the data from the Dance Only condition. The top graph shows the judgments of section ends. These co-occurred with the ends of the musical sections and their repetitions. A few judgments of section ends were also found in the middle of the sections in measures 9 - 28 and 45 - 64. As can be seen in the second graph, judgments of new ideas occurred at the beginning
Figure 1. Shows the results from the Music Only condition. The top graph shows the percentage of participants judging that a section end occurred within each window of time. The second graph shows the percentage of participants judging that a new idea occurred within each window of time. The third graph shows the judged amount of tension, and the fourth shows the judged amount of emotion expressed. Vertical lines in the graphs indicate the temporal locations of the ends of the musical sections shown by the measure numbers. The form of the piece is shown schematically at the bottom of the piece.

of each musical section. A few additional judgments of new ideas occurred in the middle of the sections in measures 9 - 28, 29 - 44, and 45 - 64. Generally, the section end judgments were followed soon thereafter by new ideas; the values in these graphs correlated strongly, \( r(\text{df} = 837) = .572, p < .0001 \). As shown by the schematic diagrams at the bottom of Figure 2, these judgments corresponded to new formations of the eight dancers.

The third and fourth graphs show the judgments of tension and emotion expressed; these correlated strongly, \( r(\text{df} = 851) = .919, p < .0001 \). Both measures tended to increase after new ideas were introduced and decrease at section ends. Tension judgments correlated negatively with both section ends and new musical ideas, \( r(\text{df} = 837) = -.183, p < .0001, \) and \( -.069, p = .046 \), respectively. Emotion expressed also correlated negatively with both section ends and new musical ideas.
Figure 2. Shows the results for the Dance Only condition. The major sections of the dance are indicated below the graphs. The formations of the dancers at each end are shown in the diagram at the bottom.

\[ r(df = 837) = -.165, p < .0001, \text{ and } -.074, p = .033, \text{ respectively. } \]

A general trend was found in both measures to increase throughout the piece, with the highest values reached in the final section.

- **Both Music and Dance Condition.** Figure 3 shows the data from the Both Music and Dance condition. The judgments of section ends co-occurred with the ends of the musical sections and their repetitions. A few judgments of section ends were also found in the middle of the sections in measures 9 - 28, 29 - 44, and 45 - 64. As can be seen in the second graph, judgments of new ideas occurred at the beginning of each musical section. Some additional judgments of new ideas occurred in the middle of these sections. The section end judgments were usually followed soon thereafter by new ideas; the values in these graphs correlated strongly, \( r(df = 837) = .663, p < .0001. \)

The third and fourth graphs show the judgments of tension and emotion expressed; these correlated strongly, \( r(df = 851) = .794, p < .0001. \) As before, both measures tended to increase after new ideas were introduced and decrease at section ends. Tension judgments correlated negatively with both section ends and new
Can dance reflect the structural and expressive qualities of music?

CAROL L. KRIHMANN AND DIANA LYNN SCHENCK

Figure 3. Shows the results for the Both Music and Dance condition. The major sections of the music and the dance are indicated at the bottom.

musical ideas. $r(df = 837) = -.336$ and $-.325$, respectively. Emotion expressed also correlated negatively with both section ends and new musical ideas. $r(df = 837) = -.319$ and $-.266$; all correlations were significant at $p < .0001$.

- **Comparisons Across Conditions.** The first across-condition analyses examined the correspondences between the Both Music and Dance condition and the Music Only and Dance Only Conditions. Table 1 shows both multiple and simple correlations between these conditions. For all four tasks, the Both Music and Dance condition could be predicted very well as a weighted additive combination of the Music Only condition and the Dance Only condition; the multiple correlations were all highly significant. For all four tasks, the standardized coefficient for the Music Only condition exceeded that for the Dance Only condition, although both contributed significantly to the multiple correlation. This difference between Music Only and Dance Only conditions was also reflected in the simple correlations with the Both Music and Dance condition, shown in the right column. Thus, the data in the Both Music and Dance condition could be explained well as a combination of the data in the Music Only and the Dance Only conditions, with the former making a stronger contribution.
Table 1
Comparisons Across Conditions
Both Music and Dance Condition Predicted by Music Only and Dance Only Conditions

<table>
<thead>
<tr>
<th></th>
<th>Section Ends</th>
<th>New Ideas</th>
<th>Tension</th>
<th>Emotion Expressed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R(2,836) = .846, p &lt; .0001</td>
<td>R(2,836) = .841, p &lt; .0001</td>
<td>R(2,836) = .851, p &lt; .0001</td>
<td>R(2,836) = .776, p &lt; .0001</td>
</tr>
<tr>
<td>Music Only</td>
<td>Standardized Coefficient .766, p &lt; .0001</td>
<td>Standardized Coefficient .744, p &lt; .0001</td>
<td>Simple Correlation .815, p &lt; .0001</td>
<td>Simple Correlation .741, p &lt; .0001</td>
</tr>
<tr>
<td>Dance Only</td>
<td>.187, p &lt; .0001</td>
<td>.221, p &lt; .0001</td>
<td>.329, p &lt; .0001</td>
<td>.663, p &lt; .0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The next analyses examined the correspondences between the Music Only and the Dance Only conditions. The data in these two conditions were significantly correlated for all four tasks: section ends, r(df = 837) = .330; new ideas, r(df = 837) = .318; tension, r(df = 851) = .529; emotion expressed, r(df = 851) = .741, all p < .0001. That is, despite the fact that these two conditions contained none of the same stimulus materials, the four tasks all gave rise to similar responses.

Finally, Figure 4 shows the average ratings for the thirteen emotion terms that were made at the end of the experiment. As can be seen, all three conditions produced highly similar patterns of ratings. The multiple correlation predicting the Both Music and Dance condition from the Music Only and the Dance Only conditions was R(2,10) = .953, p < .0001, with a higher standardized coefficient for the Music Only condition, .637, p = .012, than for the Dance Only condition, .342, p = .130. The simple correlations between conditions were: Music Only and Both Music and Dance, r(df = 11) = .940; Dance Only and Both Music and Dance, r(df = 11) = .907; and Music Only and Dance Only, r(df = 11) = .888, all correlations significant at p < .0001. Again, despite the fact that the Music Only and Dance Only conditions contained none of the same stimulus materials, they produced highly similar judgments of emotional responses.
Can dance reflect the structural and expressive qualities of music?
CAROL L. KRR, MIHRA Y. AND DIANA LYNN SCHENCK

Emotion Quality

![Graph showing emotion quality ratings for Music Only, Dance Only, and Both Music and Dance.]

Figure 4. Shows the ratings made by participants at the end of the experiment. Ratings were made on thirteen emotion scales in each of the three conditions: Music Only, Dance Only, and Both Music and Dance.

DISCUSSION

The results of the experiment quite strongly support the idea that observers are sensitive to correspondences between music and dance. Analyses of the data showed correlations between the Music Only and the Dance Only conditions in all four online tasks. That is, section ends and new ideas tended to coincide in the music and the dance, and the curves of tension and emotion expressed were also similar. This was true even though these conditions used completely different stimulus materials. In addition, the judgments of global emotional responses were very similar in the two conditions. Some minor differences between conditions should be noted, however. The delineation of temporal units by section ends and new ideas was clearest in the Music Only condition, which also exhibited the greatest and most regular variability in tension and emotion expressed. In contrast, the segmentation in the Dance Only condition appeared primarily at a higher hierarchical level, with fewer subdivisions, and the profiles of tension and emotion expressed were somewhat
smoother, showing less local variation. In addition, unlike the Music Only condition, these profiles exhibited a general trend toward a peak in the final section of the piece, replicating on the highest level the pattern found in subsections. This finding is also consistent with Jordan's (1993) description of Balanchine's choreographic style that builds the general level of tension throughout the piece.

An advantage of the on-line psychological measurements in this study is that they can guide the analysis of the materials for elements that correspond in the music and dance. As noted above, temporal segmentation in the dance occurred primarily at higher hierarchical levels, so we will focus first on larger units that exhibit parallels between the music and the dance. Table 2 summarizes these parallels. The dance consists of three main sections, each corresponding to the three sections of the minuet. The first section, or first minuet, is performed by the entire corps de ballet; this is followed by the duet pairings in the trio section, a marked change of style and form in both the dance and the music signaled by the regrouping of the dancers into a tableau formation and a change of key to G-minor; the return to the A section at the end is mirrored by a return to the use of the full complement of eight dancers, who perform some of the material from the earlier performance of A, but also execute variations on many of the steps performed by the duet pairs in the trio. Consequently, the dance reflects the essence of the minuet form without resorting to a 1:1 imitation of its structural material.

Each of these dance units subdivides into units that correspond with smaller musical sections. In the first and third sections, each of these subsections is marked by regrouping of the dancers into a new formation as shown in the table and at the bottom of Figure 2. In the middle section, the subsections are marked by the dancers regrouping into a tableau position for each of the four successive pairs. Structural parallels are also evident at smaller subdivisions. For example, the first six measures contain three repetitions of a transposed ascending melodic motive that corresponds with the two lines of dancers moving in opposition three times. Thus, the piece begins with what Hodgins (1992) would term a structural choreomusical parallel: a motive or figure in the score is mirrored by the movements of the dancers. This occurs again in the repeat of measures 1-8, as the two lines repeat steps that become associated with a particular musical motive. The dancers also generally follow the placement of accents in the score, with accented notes often accompanied by more emphasized movements of the dancers.

Following Hodgins' (1992) technique further, it is possible to find quite a few other intrinsic parallels in this selection. Rhythmic parallels are easily observed, as Balanchine keeps to a strict 3/4 pulse, and rarely deviates from the two-, four-, and eight-measure hierarchies of the music. Dynamic parallels are also rather obvious, as in measure 23, second time through, when the dancers perform quicker steps and high jetés as the music crescendos to a forte. This is also an example of tessitura parallels, which fall into Hodgins's qualitative category, since the highness of the notes in the passage is mirrored in the higher steps and leaps of the dancers. Other quali-
Table 2
Comparisons between Music and Dance

<table>
<thead>
<tr>
<th>Minuetto:</th>
<th>Music</th>
<th>Dance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-8</td>
<td>a</td>
<td>Lines move in opposition (3 times), regroup into diagonal lines</td>
</tr>
<tr>
<td>1-8</td>
<td>a</td>
<td>Lines move in parallel (2 times), turn out, regroup in circle</td>
</tr>
<tr>
<td>9-18</td>
<td>b</td>
<td>Opposite pairs cross (3 times), regroup in lines</td>
</tr>
<tr>
<td>19-24</td>
<td>a'</td>
<td>Opposite pairs side-to-side (2 times), opposite pairs cross (2 times)</td>
</tr>
<tr>
<td>25-28</td>
<td>coda</td>
<td>Regroup into parallel lines</td>
</tr>
<tr>
<td>9-18</td>
<td>b</td>
<td>Side pairs meet and separate (4 times)</td>
</tr>
<tr>
<td>19-24</td>
<td>a'</td>
<td>Form inverted V, turn out, cross through, form V</td>
</tr>
<tr>
<td>25-28</td>
<td>coda</td>
<td>Regroup into tableau position for first pair</td>
</tr>
</tbody>
</table>

Trio:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>29-36</td>
<td>c</td>
<td>Duet 1</td>
</tr>
<tr>
<td>37-44</td>
<td>d</td>
<td>Duet 1, regroup into tableau position for next pair</td>
</tr>
<tr>
<td>29-36</td>
<td>c</td>
<td>Duet 2</td>
</tr>
<tr>
<td>37-44</td>
<td>d</td>
<td>Duet 2, regroup into tableau position for next pair</td>
</tr>
<tr>
<td>45-52</td>
<td>c'</td>
<td>Duet 3</td>
</tr>
<tr>
<td>53-60</td>
<td>d'</td>
<td>Duet 3</td>
</tr>
<tr>
<td>61-64</td>
<td>coda</td>
<td>Duet 3, regroup into tableau position for next pair</td>
</tr>
<tr>
<td>45-52</td>
<td>c'</td>
<td>Duet 4</td>
</tr>
<tr>
<td>53-60</td>
<td>d'</td>
<td>Duet 4</td>
</tr>
<tr>
<td>61-64</td>
<td>coda</td>
<td>Regroup into lines</td>
</tr>
</tbody>
</table>

Da capo:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-8</td>
<td>a</td>
<td>Lines move in opposition (3 times), regroup into X pattern</td>
</tr>
<tr>
<td>9-16</td>
<td>b</td>
<td>Inside and outside pairs change position</td>
</tr>
<tr>
<td>17-24</td>
<td>a'</td>
<td>Variations on steps from duets</td>
</tr>
<tr>
<td>25-28</td>
<td>coda</td>
<td>Regroup into lines and move off-stage</td>
</tr>
</tbody>
</table>

tative choreomusical parallels are correspondences between the "sharpness or smoothness" (Hodgins, 1992) of the dance steps and arm positions and the use of staccato or legato markings in the score. The legato, arc motive in measures 9-18, second time through, is accompanied by smooth, graceful, "low-key" movements, while the triumphant, marcato horn arpeggio found in measures 23-4 and 43-44 (both times) is fleshed out each time by a similarly marcato pas de chat jump. Overt dynamic category parallels follow along this line, as fortés and pianos are accompanied by corresponding larger, stronger movements, or smaller and more delicate movements. For example, bars 19-22, first time through, are performed at a piano
dynamic as the dancers execute delicate pointe work and graceful arabesques; as the
dynamic changes suddenly from piano to a solid forte, the dancers cross through
each other with forceful jetés, stronger arm positions, and emphatic turns. These
kinds of features can account for the strong correspondences between the music and
the dance reflected in the four on-line tasks. Thus, there appear to be a large num-
ber of dimensions available in the two modalities to establish structural mappings
between the two domains, suggesting non accidental mappings between music and
the bodily movement in the dance.

It is more difficult to account for the similar judgments of global emotions found
in the Music Only and Dance Only conditions. Both conditions produced high rat-
ings of Amused, Contented, Happy, and Interested. Given the present data, we can
only speculate on what produces these similar emotional responses. Some factors
that seem plausible for this particular selection are the tempo of the music and the
dance, melodic and choreographic gestures, and the high degree of symmetry and
regularity in both music and dance. Additional factors may be the pacing of seg-
ment endings and new ideas, and the experienced contours of tension and emotion
expressed. A large number of studies have tested whether verbal labels of emotions
can be consistently associated with music. These studies (e.g., Hevner, 1935, 1936;
Wedin, 1972; Brown, 1981; Gregory & Varney, 1996) find varying degrees of con-
sistency and suggest a large number of musical attributes may be involved in pro-
ducing these associations. These attributes include general properties such as tempo,
dynamics, modality, and dissonance, as well as more specific aspects of musical
structure and performance (e.g., Senju & Ohgushi, 1987; Sloboda, 1991; Gabrielson
& Justlin, 1996). The present finding that music and dance can produce similar
emotional representations suggest they are also carried to some extent by properties
with cross-modal analogs.

An additional question of interest in the present study was how music and dance
combine in the psychological representation. To address this, the results from the
Both Music and Dance condition were compared with the Music Only and the
Dance Only conditions. One possibility is that the results in the former are a com-
bination of the other two conditions that combine in an additive, non-interactive
fashion. Another possibility is that there is an interaction between the two, in which
the combined effect is greater than or different from the sum of the two com-
ponents. The analyses of the present data support the former possibility. The data in
the Both Music and Dance condition were modeled well by a weighted additive
combination of the data in the Music Only and the Dance Only conditions. For all
tasks, the analyses found somewhat greater weight for the Music Only data than the
Dance Only data. It is noteworthy that this non-interactive relationship between
music and dance is similar to that found for musical pitch and rhythm (e.g., Mon-
ahan & Carterette, 1985; Palmer & Krumhansl, 1987 a, b).

The possibility of stylistic limits to these results should be emphasized, however.
Balanchine is noted for giving special attention to the music in his choreography,
and the relatively strong correspondences between music and dance noted earlier may contribute to explaining the additive, non-interactive relationship found here. Even for Balanchine, more complex relationships between the music and dance appear in other pieces. As noted by Jordan (1993), other pieces (including another movement in this Divertimento) contain deliberate metrical disparities between the music and the dance. Other choreographers, notably Merce Cunningham, are known for creating marked oppositions between the two components. Psychologically, these disparities might produce more complex interactions between the two components. For example, tension may be produced not only by the music and dance, but also by the disparities between them. Similarly, the relative dominance of the music found in this experiment may be a function of the particular selection chosen.

Finally, in all three conditions the four on-line tasks showed consistent temporal patterns with one another. New ideas were judged as occurring at section beginnings when levels of tension and emotion expressed were low. These levels tended to increase throughout the sections, reaching peaks just before the section ends, and then declining rapidly. The finding that this temporal pattern appeared in all conditions suggests that a general schema for temporal organization is operating. This pattern was also found in the previous study by Krumhansl (1996), where it was compared with discourse structure in language (Chafe, 1994). Again, it should be noted that the generality of the schema may be limited to only certain styles of music and dance. Both the present and the previous studies used pieces by Mozart written in the classical style, which is frequently compared with discourse (Ratner, 1980, 1991). That the pattern also appears in the dance may be due to Balanchine's attentiveness to the music, as noted above. Thus, while the present results suggest that this schema for temporal organization is available for both music and dance, it should not be assumed to be obligatory for all styles.

This exploratory study raises a number of questions that only further research can address. First, a number of methodological issues arise. The present on-line tasks were designed to be general enough to apply to both dance and music. Other tasks and instructions might uncover additional aspects of the psychological representation of music and dance. Also, the choice of tasks and the specific order in which they were presented may have influenced the present results to some degree. In addition, as already emphasized, the findings here are specific to the selection chosen for the experiment. As suggested earlier, it would be of interest to study styles of dance in which the music and dance elements are less strongly correlated, even to the point that the music and dance work in opposition. In addition, examining different dances choreographed to the same piece of music would address the question of how strongly music constrains the dance. Despite the exploratory nature of the present experiment, we hope that it encourages empirical work on the various art forms linked with music. Related studies on music and film, such as those by Thayer and Levenson (1983), Marshall and Cohen (1988), and Lipscomb and Kendall (1994),...
suggest that music plays an important function in determining the affect and mood of the film and directing attention and adding meaning to particular events. Such cross-modal studies promise to contribute to our understanding of how music acquires its semantic content and affective qualities by examining the ways it coordinates with these other art forms.¹

¹ We extend our appreciation to Virginia Brooks for providing the videotape, the Balanchine Trust for permission to use it in the experiment, James Cutting for the videotape equipment and useful discussions, and to Julian Hochberg, Virginia Brooks, Rebecca Harris-Warrick, Aba Schubert, and Emmanuel Bigand for consultation on various aspects of the study. We thank the three anonymous reviewers for insightful comments on an earlier version of this article.

Address for correspondence: Carol L. Krumsdol, Department of Psychology, Uris Hall, Cornell University, Ithaca, NY 14853 USA (e-mail: clk4@cornell.edu).
Can dance reflect the structural and expressive qualities of music?
CAROL L. KRUMHANL AND DIANA LYNN SCHENCK

REFERENCES


Can dance reflect the structural and expressive qualities of music?

Carol L. Krumhansl and Diana Lynn Schenck


---

*Puede la danza reflejar las cualidades estructurales y expresivas de la música? Estudio perceptivo de la coreografía de Balanchine sobre el Divertimento nº 15 de Mozart*

Un experimento perceptivo investiga las líneas estructurales y expresivas entre la música y la danza. El material experimental se ha basado en el *Minuetto del Divertimento nº 15* de W. A. Mozart, coreografiado por George Balanchine. Los participantes han sido asignados a una de las tres condiciones posibles siguientes: música sola, danza sola, y música y danza. Realizaron cuatro tareas conexas: indicar los fines de sección y las nuevas ideas y juzgar el grado de tensión y de emoción expresada. Cualquiera que fuera la tarea, los resultados fueron extremadamente similares para las tres condiciones, incluyendo la música y la danza solas, donde todos los estímulos son, no obstante, distintos. Del análisis de la música y de la danza resulta que una gran variedad de elementos entran en la determinación de las líneas de la música y la danza. Como ambas intervienen en niveles jerárquicos diferentes, las relaciones entre la música y el movimiento corporal no parecen ser de naturaleza fortuita. Se podría esperar que la condición música y danza fuera percibida como una combinación de música sola y danza sola, y dominada más claramente por la danza. Los resultados indican en efecto una relación suplementaria, no interactiva, entre la música y la danza. El patrón temporal de las tareas es idéntico en las tres condiciones: introducción de nuevas ideas en los comienzos de sección, acompañada de bajos niveles de tensión y de emoción. Estos niveles tienden a acentuarse en el interior de las secciones, situándose la cima justo antes de los fines de sección. Se deduce que un mismo esquema general de la organización temporal opera en los niveles de la música y la danza. Finalmente, las tres condi-
ciones generan tipos extremadamente semejantes de respuesta emocional, lo que confirma la idea según la cual la música y la danza comprometen representaciones emocionales similares.

- La danza può riflettere la struttura e le qualità espressive della musica? Un esperimento percettivo sulla coreografia di Balanchine del Divertimento n° 15 di Mozart

In questo lavoro si indaga sulle curve strutturali ed espressive di musica e danza. Il materiale stimolo è stato preso dal Minuetto del Divertimento N. 15 di W. A. Mozart, coreografato da George Balanchine. I partecipanti sono stati sottoposti ad una delle tre condizioni seguenti: Solo Musica, Solo Danza, sia Musica che Danza. Essi hanno eseguito in modo interattivo quattro compiti indicando ciò che si verifica alla fine del pezzo e la nuova idea e valutando la quantità di tensione ed emozione espressa. Ciascuno dei compiti ha mostrato una forte similitudine nelle tre condizioni compresse le condizioni Solo Musica e Solo Danza nelle quali i due stimoli erano distinti. L’analisi della musica e della danza ha evidenziato una gamma di elementi che determina le curve di musica e danza. Queste operano su livelli gerarchici differenti e suggeriscono una connessione non casuale tra musica e movimento corporeo. La condizione di Musica e Danza contemporaneamente può essere predetta come una combinazione delle condizioni di Solo Musica e Solo Danza, con un maggiore contributo della prima. I risultati indicano un ulteriore relazione, non interattiva, tra musica e danza. Tutte e tre le condizioni hanno dimostrato le medesime configurazioni temporali: nuove idee nella sezione iniziale quando i livelli di tensione e di emozione espressi sono minimi. Questi livelli tendono ad aumentare all’interno delle sezioni raggiungendo il massimo poco prima che la sezione finisca. Questi risultati suggeriscono che un medesimo schema generale dell’organizzazione temporale agisce sia nella musica che nella danza. Infine le tre condizioni hanno prodotto giudizi unanime di risposta emotionale, convalidando l’idea che la musica e la danza utilizzano le stesse rappresentazioni emozionali.

- La danse reflète-t-elle les qualités structurelles et expressives de la musique? Etude perceptive de la chorégraphie du Divertimento n° 15 de Mozart par Balanchine

On étudie ici la perception des courbes structurelles et expressives de la musique et de la danse. Le matériau expérimental est extrait du Minuett du Divertimento n° 15 de Mozart dont George Balanchine a réalisé une chorégraphie. Les sujets sont soumis à l’une des trois conditions suivantes — la Musique Seule, la Danse Seule, la Musique et la Danse — et doivent effectuer quatre tâches connexes : indiquer les fins de section et les nouvelles idées et juger le degré de tension et d’émotion exprimée. Quelle que soit la tâche, les résultats sont extrêmement semblables pour les trois conditions, y compris la musique et la danse seules où tous les stimui sont cependant distincts. Il ressort de l’analyse de la musique et de la danse qu’une grande variété d’éléments entrent dans la détermination des courbes.
Can dance reflect the structural and expressive qualities of music?
CAROL L. KRAMHANSTE AND DIANA LYNN SCHENCK

de la musique et la danse. Comme elles interviennent à différents niveaux hiérarchiques, les relations entre la musique et le mouvement corporel ne semblent pas être de nature fortuite. On pouvait s'attendre à ce que la condition Musique et Danse soit perçue comme une combinaison des deux autres et plus nettement dominée par la danse. Les résultats y indiquent en effet une relation supplémentaire, non interactive, entre la musique et la danse. Le pattern temporel des tâches est identique dans les trois conditions : introduction de nouvelles idées aux débuts de section, accompagnée de faibles niveaux de tension et d'émotion. Ces niveaux tendent à s'accroître à l'intérieur des sections, le sommet se situant juste avant les fins de section. On en déduit qu'un même schéma général de l'organisation temporelle est mis en œuvre aux niveaux de la musique et de la danse. Enfin, les trois conditions génèrent des types extrêmement semblables de réponse émotionnelle, ce qui conforte l'idée selon laquelle et la musique et la danse font appel à des représentations émotionnelles identiques.

* Kann Tanz die strukturellen und expressiven Qualitäten der Musik wiederspiegeln? Ein Wahrnehmungsexperiment zur Choreographie von G. Balanchine zum Divertimento Nr. 15 von W. A. Mozart.