Psychology of Music,
1996, **24,** 3–17

Does Formal Musical Structure Affect Perception of Musical Expressiveness?

BARBARA TILLMANN AND EMMANUEL BIGAND
Faculté des Sciences, Université de Bourgogne, 6 Boulevard Gabriel, Dijon Cedex, France.

Abstract

The aim of the study was to assess the effect of systematic modifications in global musical structures on perceived expressiveness. Recorded performances of piano pieces of Bach, Mozart and Schönberg were segmented into short chunks of six seconds in average. These chunks were linked either in a forward order (Original version) or in a backward order (Inverted version). In the inverted version, the formal global structure of the pieces was destroyed, but the superficial features and the local structures inside the chunks were unaltered. Forty non-musician subjects were required to rate the musical expressiveness of these pieces on 29 semantic scales. Half listened to the three original versions, the other half to the three inverted versions. For both groups there was a strong effect of musical pieces on expressiveness. However, the effect of the version, *i.e.* forward or backward ordering of the chunks, was small and that was found for the Schönberg piece. For the Bach and the Mozart pieces, playing the chunks in a forward or backward order affected neither the expressiveness, nor the feeling of coherence. These findings suggest that short chunks contain enough information to define expressiveness for non-musician listeners. These results agree with previous ones reported by Gotlieb and Konečni (1985), Cook (1987), Karno and Konečni (1992), and raise the question of the psychological reality of global musical structures.

Introduction

There are several ways in which music can induce expressiveness and in which music can represent and evoke emotion and meaning for the listener. Following the work of Peirce (1931–1935), Dowling and Harwood (1986) suggest that musical pieces may arouse emotions previously associated with them (index), may mimic the form of emotional experience (icon), and/or may derive their meaning from their syntactic structure (symbol). Iconic and symbolic representations differ slightly by the importance they confer to superficial versus structural features of the pieces. Intensity, dynamics, timbre, rhythm and melodic contours are very important superficial cues for the iconic representation. For example, a flowing rhythm led listeners to select adjectives such as happy, joyous and sprightly (Hevner, 1936). According to Scherer and Oshinsky (1977), melodic contour, rhythm, dynamism and tempo are important features which convey emotion in both music and speech. On the other hand, the symbolic conception highlights the importance of the structural relationships that exist between musical events. It is generally assumed that musical sequences are meaningful because of their structural relations with other musical passages in the piece (Meyer, 1956; Batt, 1987). "A musical phrase, no matter how beautiful it is, reaches its expressive summit only when it is in perfect harmony with preceding and following phrases. What would be a musical piece whose parts, far from working as a whole, could be suppressed, replaced, transplanted?" (Hodeir, 1951, p.15). The aim of the present study was to take literally Hodeir's

affirmation and to empirically investigate the link between the global form of musical pieces and the musical expressiveness.

In the Western tonal music system, the global form of musical pieces relies on both motivic and harmonic structures (D'Indy, 1897). Musical themes are exposed, varied, developed and, finally, exposed again at the end of the piece. Such thematic development defines motivic relations between the different parts of the piece (Francès, 1958). Harmonic progressions also follow a formal organisation. Western tonal musical pieces start in a main key, move through other keys (relatively near to or far from the starting key) and then finally return to the main key. According to Schenker (1935), Meyer (1956), Lerdahl and Jackendoff (1983) and Lerdahl (1991), harmonic structures confer a strong unity to tonal musical pieces because they instil hierarchical relationships between all the musical events of the piece. From a psychological point of view, the combination of motivic and harmonic structures ideally enables listeners to integrate local information contained in short musical chunks into more global patterns (Francès, 1958; Deutsch and Fereo, 1981; Dowling and Harwood, 1986). As quoted by Meyer (1973) "If musical stimuli [...] did not form brief, but partially completed events (motives, phrases, etc.), and if these did not in turn combine with one another to form more extended, higher-order patterns, all relationships would be local and transient – in the note to note foreground" (p. 80).

For most music theorists and psychologists, higher-order patterns mainly govern the aesthetic and hedonic effect of music on listeners. This is because they lead to the generation of local and global expectancies in the rest of the piece (Meyer, 1956; Jones, 1987; Boltz, 1993; Krumhansl, 1990; Schmuckler, 1989; Jackendoff, 1991). Expressive or significant moments in music arise from a violation or from an unforeseen conclusion of the listener's musical expectations (Sloboda, 1991). There is therefore a phenomenon of prospective hearing, that is to say, musical anticipation of the abstract structures about to appear, and a phenomenon of retrospective hearing that accounts for various sorts of "satisfaction", "shock", or "surprise", associated with hearing music (Jackendoff, 1991). Accordingly, we may assume that destroying the global motivic and harmonic structures of a tonal piece of music should create a lot of "surprises" and "shocks" for listeners, that in turn should significantly affect musical expressiveness and feelings of coherence.

Contrary to Western tonal music, thematic and harmonic structures are absent in twelve tone music. Twelve tone music relies on a serial compositional method that differs from a thematic development, and that avoids any kind of hierarchy (Griffiths, 1978; Vuillermoz, 1973). The musical structure is derived from several sorts of transformation (inversion, retrograde, retrograde inversion) applied to an original set of tones. Historically, there has been a continuing controversy about the ability of such new compositional systems to generate pleasant or structured musical pieces. Some experiments have provided evidence that serial transformations are difficult to perceive (Dowling, 1972), and memorise (Francès, 1958). This difficulty strongly affects the perception of the global structure of the piece (Francès, 1958). Though some global forms can be defined (Lerdahl, 1989), the global musical form completely disappears in twelve tone music, so that listeners would have to use other ways of listening and memorising (McAdams, 1988) and have more difficulty in developing expectations about the rest of the piece

(Krumhansl, Sandell and Sergeant, 1987). Therefore, we may assume that systematic modifications in atonal musical pieces should alter perceived musical expressiveness to a lesser extent than for tonal musical pieces.

Some studies have attempted to empirically investigate the link between global structure and musical expressivity. Imberty (1981) found some relationships between the extent of the hierarchical nature of the musical structures perceived by listeners, and the perceived expressiveness of the musical pieces. The perceived grouping structures of a Brahms intermezzo and the Debussy *Puerta del vino* were first investigated through a segmentation task. The expressiveness of both pieces were then investigated in a second part of the experiment. The Brahms piece, that was perceived as having a strong grouping hierarchy, evoked feelings of joy and serenity. On the contrary, the Debussy piece, whose perceived grouping structure was weakly hierarchic, evoked feelings of sadness, uncertainty, and violence. According to Imberty (1981) a piece with a weak formal structure may evoke negative semantic connotations because it relates back to experiences of disintegration of the self and the internal life.

However, experimental studies that introduced systematic variations in musical structures have not confirmed the importance of global form on perceived musical expressiveness. The direct influence of large-scale tonal closure was investigated by Cook (1987). The final key of several musical excerpts was changed, so that the excerpts ended in a key other than the main key. The direct influence of large-scale tonal closure on listeners' feelings of coherence, completion, pleasure and expressiveness was relatively weak and was restricted to fairly short time spans. The effect of systematic modifications of the entire structure of musical pieces has been investigated by Konečni (1984), Gotlieb and Konečni (1985), and Karno and Konečni (1992). Konečni (1984) observed that playing the movements of a Beethoven sonata in an altered order did not affect enjoyment. In a similar way, playing the Bach Goldberg variations in a random order did not affect hedonic judgement (Gotlieb and Konečni, 1985). Moreover, changing the order of different sections of the first movement of Mozart's Symphony (K 550) did not alter ratings of pleasure, interest or desire to own a copy of it (Karno and Konečni, 1992) for non-musically trained (Experiment 1) as much as for musically trained listeners (Experiment 2). Such results suggest that, even for tonal musical pieces, the effect of large musical structure on expressiveness may be weaker for listeners than generally assumed.

The purpose of the present experiment was to go one step further in performing more drastic modifications in musical pieces than did Karno and Konečni (1992). Three piano pieces, two tonal and an atonal one, were segmented into short musical chunks of an average of six seconds. According to Fraisse (1957, 1992), this duration corresponds to the time interval during which successive auditory events may be simultaneously kept in conscious awareness. Perceptual chunks rarely exceed six seconds in length, which exerts a strong constraint on the perception of successive auditory events (McAdams, 1989; Bigand, 1993). In one experimental situation, these chunks were linked in a forward order (Original version). In the other experimental situation, they were linked in a backward order (Inverted version). This systematic variation totally destroyed the structure of the pieces as a unitary whole, without altering the local structures inside chunks and the superficial features. The large-scale tonal modulation, variation on theme

and the global development of the piece are destroyed. The musical flow leads nowhere, and no global development is possible any longer. Figure 1 shows the first seven chunks of the Mozart piece used in the present study. In the inverted versions these seven chunks appeared at the end of the piece (... G-F-E-D-C-B-A). Local transitions were possible, but an incoherence on a global level was created: the consequent is followed by the antecedent and the bridge is followed by the exposition of the motif.

Expressive responses of the listeners were recorded on 29 semantic–differential bipolar scales, ranging in content from hedonic to coherence and expressiveness. If global structure influences perceived musical expressiveness, a backward ordering of the chunks should modify the subjects' ratings on these semantic scales. According to Imberty (1981), changes in ratings should express more negative meanings. Moreover, the effect of version on the subjects' ratings should be more pronounced for the tonal than for the atonal pieces. In addition, different musical pieces should provoke different patterns of ratings.

Method

Subjects

Forty students of the University of Burgundy performed the experiment. Twenty-seven had no musical experience and thirteen had relatively little instrumental practice (from 1 to 4 years). Most of the subjects were familiar with serious music, but none of them knew the presented pieces. One person recognised the style, but not the work itself.

Stimuli

Three piano pieces were used: the Bach gigue of the French Suite no. 1 in D minor, BWV 812 (length: 2:07 min.), played by G. Gould; the Mozart allegretto of the Sonata in B flat major, KV 570 (length: 3:28 min.), played by M.-J. Pires; and the Schönberg gigue of piano suite op. 25 (length: 2:25 min.), played by C. Helfer. The Bach gigue is representative of the contrapuntal style of the baroque period. The Mozart allegretto illustrates the sonata form of the classical period. The Schönberg gigue of the opus 25 is representative of the new twelve-tone compositional system. The gigue was chosen because of its humouristic character (Tranchefort, 1987). The three piano pieces shared similar dynamic aspects. Each piece was entirely segmented in several chunks according to the three following criteria: (1) as far as possible, the chunks must be congruent with the local musical structure of the piece, (2) they must be linked with other chunks without creating crude acoustic transitions, (3) they must last about six seconds. The Bach gigue was cut into 21 chunks (average duration, 5·28 sec.), the Mozart allegretto into 29 chunks (average duration, 6·40 sec.) and the Schönberg gigue into 27 chunks (average duration, 5·10 sec.) (see Table 1). The chunks were recorded and linked with the Sound Designer II software. Sound Designer II avoided any acoustic noise due to linking non-adjacent parts of the piece. In the original version, all the chunks were linked forward. In the inverted version, all chunks were linked backward. In order to create a fairly realistic beginning and end of the musical piece in the inverted versions, the original final chunks of the three pieces were slightly modified at the beginning of the inverted versions and were played again at the end.

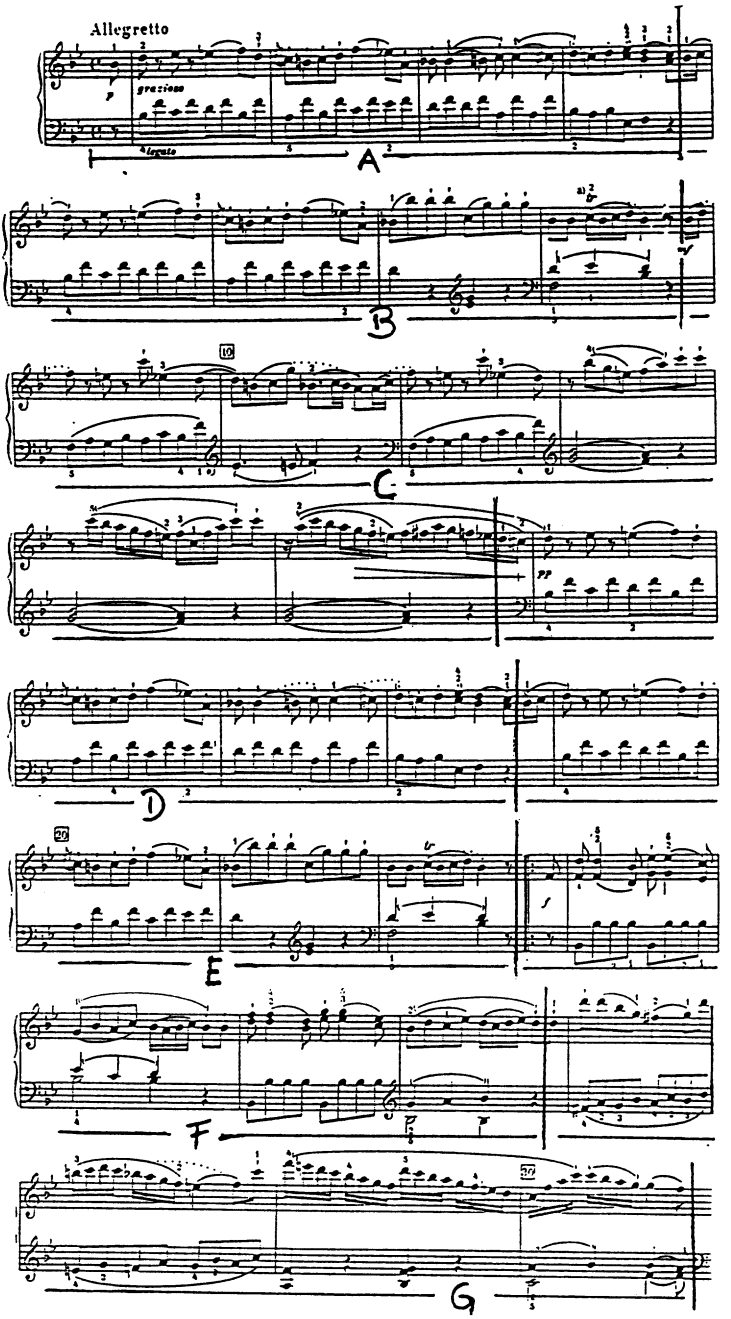

FIG. 1

The first seven chunks of the Mozart piece used in the study. For the original version chunks are linked in the order: A-B-C-D-E-F-G, for the inverted version: G-F-E-D-C-B-A.

TABLE 1

Chunks of the Bach, Mozart and Schönberg pieces.

Bach				Mozart					Schönberg				
	start	end			start	end				start	end	
sec.	bar	bar	beat	chunk	sec.	bar	bar	beat	chunk	sec.	bar	bar	beat
5:21	1	3	1	1	6:29	1	4	4	1	5:01	1	4	2
5:20	3	5	1	2	6:23	4	8	3	2	6:11	5	9	3
5:25	5	7	1	3	10:05	8	14	4	3	6:03	10	13	2
8:13	7	10	1	4	6:28	14	18	4	4	4:12	14	16	3
8:25	10	12	2	5	6:28	18	22	4	5	4:14	17	19	2
5:22	1	3	1	6	6:24	23	26	4	6	5:02	20	23	2
5:23	3	5	1	7	6:21	26	30	4	7	3:05	23	25	5
6:00	5	7	1	8	6:28	23	26	4	8	4:29	1	4	2
5:27	7	9	1	9	6:24	26	30	4	9	6:19	5	9	3
3:00	9	10	1	10	7:07	31	34	4	10	6:09	10	13	2
9:06	10	12	2	11	6:22	34	38	4	11	4:12	14	16	3
6:04	13	15	1	12	6:21	38	42	4	12	4:15	17	19	2
5:24	15	17	1	13	7:12	31	34	4	13	5:05	20	23	2
3:04	17	18	1	14	3:15	34	36	4	14	4:20	23	26	4
5:08	18	19	2	15	3:13	36	38	4	15	4:17	27	28	4
6:25	19	22	1	16	6:18	38	42	4	16	5:11	29	32	2
4:16	22	23	2	17	3:23	43	44	4	17	5:27	32	38	1
4:22	23	25	1	18	6:30	45	48	4	18	4:08	38	39	3
4:25	25	26	2	19	6:24	45	48	4	19	7:03	39	42	4
5:28	26	28	1	20	6:29	49	52	4	20	8:04	43	46	3
4:22	28	28	2	21	6:23	53	56	4	21	5:00	47	50	5
				22	7:00	49	52	4	22	3:01	51	53	1
				23	6:24	53	56	4	23	6:10	53	58	2
				24	6:20	57	60	4	24	8:01	58	64	1
				25	7:02	62	66	4	25	6:23	64	68	5
				26	6:26	66	70	4	26	5:02	69	72	5
				27	13:20	70	78	4	27	3:06	73	75	3
				28	11:15	78	85	3					
				29	9:07	85	89	4					

Procedure

In the first part of the experiment, subjects listened to the three pieces and were required to focus on the impressions and feelings the music evoked for them. In order to render the inverted versions as realistic as possible, these versions were presented to subjects as "excerpts of musical pieces that do not necessarily start and finish at the real beginning or end". In the second part of the experiment, the subjects heard each piece again and then rated the expressiveness of the piece on 27 bipolar semantic scales. They were required to evaluate the impressions and feelings the music evoked for them. Half of the subjects heard the three original versions, the other half the three inverted versions. The presentation orders of the pieces for the first and second parts of the experiment were counterbalanced across the subjects. The semantic scales contained 11 steps, ranging from

TABLE 2

Summary of the 27 univariate analyses of variance for the French bipolar scales.

	Scale	*Significant effect*	*F*	
1	Détente/tension	factor piece	(2,76)=110·9	$p<0·001$
2	Déplaisant/plaisant	factor piece	(2,76)=45·34	$p<0·001$
3	Humilité/audace	factor piece	(2,76)=16·26	$p<0·001$
4	Mélancolie/bonheur	factor piece	(2,76)=43·63	$p<0·001$
5	Douceur/Agressivité	factor piece	(2,76)=113·06	$p<0·001$
6	Drôle/sérieux	factor piece	(2,76)=38·39	$p<0·001$
7	Intolérance/tolérant	factor piece	(2,76)=39·59	$p<0·001$
8	Angoissant/sécurisant	factor piece	(2,76)=98·89	$p<0·001$
9	Austérité/sensualité	factor piece	(2,76)=30·32	$p<0·001$
10	Épanouissement/frustration	factor piece	(2,76)=53·77	$p<0·001$
11	Attrayant/banal	factor piece	(2,76)=6·24	$p<0·01$
12	Déprimant/enthousiasmant	factor piece	(2,76)=36·77	$p<0·001$
13	Hostilité/bienveillance	factor piece	(2,76)=98·29	$p<0·001$
14	Éclatant/terne	factor piece	(2,76)=13·11	$p<0·001$
15	Repos/dynamique	factor piece	(2,76)=24·68	$p<0·001$
16	Fantaisiste/ordonné	factor piece	(2,76)=26·85	$p<0·001$
17	Simple/bizarre	factor piece	(2,76)=92·75	$p<0·001$
18	Emporté/paisible	factor piece	(2,76)=44·1	$p<0·001$
19	Pesant/léger	factor piece	(2,76)=64·38	$p<0·001$
20	Agréable/agaçant	factor piece	(2,76)=50·1	$p<0·001$
21	Clair/mystérieux	factor piece	(2,76)=63·27	$p<0·001$
		factor version	(1,38)=5·89	$p<0·02$
22	Passionné/calme	factor piece	(2,76)=17·23	$p<0·001$
23	Joyeux/triste	factor piece	(2,76)=48·1	$p<0·001$
24	Dégoût/beauté	factor piece	(2,76)=40·88	$p<0·001$
25	Allègre/nostalgique	factor piece	(2,76)=27·67	$p<0·001$
26	Impulsif/contrôlé	factor piece	(2,76)=56·45	$p<0·001$
		factor version	(1,38)=4·84	$p<0·05$
		interaction	(4,35)=3·41	$p<0·05$
27	Désespérant/plein d'espoir	factor piece	(2,76)=49·29	$p<0·001$

–5 to +5 (Osgood, Suci and Tannenbaum, 1957). The first fifteen semantic scales were a French translation of the semantic scales used by Caspy, Schlain and Goldberg (1988). They encapsulate opposing feelings of tension and relaxation, feelings of aggression and sweetness, and so on (see Table 2). The next twelve scales that were added were based upon the previous empirical studies of Gottesdiener (1969) and Imberty (1978). Subjects' judgements on the piece itself (Cook, 1987) were recorded with regard to supplementary scales: coherence–incoherence; expressive–inexpressive. At the end of the experiment, the experimenter explained how the three pieces had been modified and subjects had to indicate if they had listened to the original or the inverted pieces.

Results

A factor analysis was run to define the principal component factors underlying the first 27 bipolar scales. A three-factor solution explained 72·3% of the variance. The first component accounted for 48·7% of the variance, the second component for 18·7% and the third for 5·3%. Four synthetic variables were defined corresponding to the loadings of each semantic scale on these three component factors. The semantic scales whose loadings were highest on the first component factor were grouped in the first synthetic variable (*i.e.* semantic variable numbers 1, 2, 5, 7, 8, 9, 10, 12, 13, 19, 20, 23, 24, and 27; see Table 2). This first synthetic variable may be interpreted as contrasting positive (+5) with negative (–5) meanings. The second synthetic variable grouped semantic scales whose loadings were highest on the second component factor (*i.e.* semantic variable numbers 3, 15, 16, 18, 22, 25, 26; see Table 2). This second synthetic variable may be interpreted as contrasting feelings of high (+5) versus weak (–5) dynamism. The third synthetic

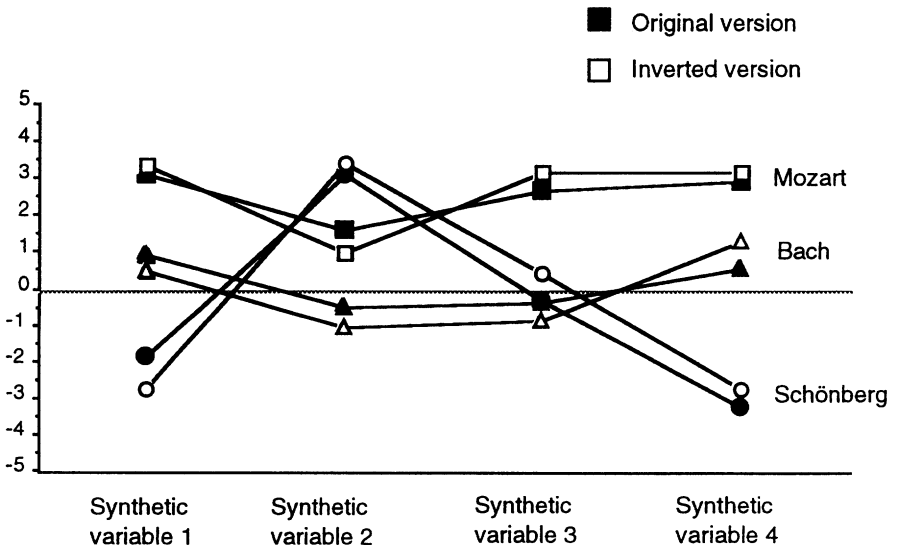

FIG. 2

Average ratings of expressiveness for each piece and each version on the four synthetic variables.

variable grouped semantic scales whose loadings were equally high on the first and second component factors (*i.e.* semantic variable numbers 4, 6, 11, 14). It may be interpreted as contrasting positive and dynamic meanings (+5) with negative and non-dynamic meanings (–5). Finally, the fourth synthetic variable grouped two semantic scales, whose loadings were highest on the third component factor (*i.e.* semantic variables numbers 17 and 21). It contrasted such feelings described as "strange", "mysterious" (–5) to "simple" and "clear" (+5). Figure 2 shows the averages of ratings recorded on each synthetic scale for the three piano pieces in the original and inverted versions. For all three pieces the first and second synthetic variables did not correlate significantly, the third synthetic variable correlated significantly with the first (Bach: $r = \cdot 68$; Mozart $r = \cdot 65$; Schönberg: $r = \cdot 64$; df = 38; $p < \cdot 01$) and the second one (Bach: $r = \cdot 39$; Mozart $r = \cdot 52$; Schönberg: $r = \cdot 57$; df = 38; $p < \cdot 01$). The fourth synthetic variable correlated significantly with the second one for the Bach piece ($r = \cdot 45$; $p < \cdot 01$) with the first one for the Mozart piece ($r = \cdot 38$; $p < \cdot 05$) and with none for the Schönberg piece.

To assess the effect of the Piece and Version factors, a 3 x 2 MANOVA was performed with the four synthetic variables as the dependent variables. The three pieces made up the within-subject variables, and the two versions made up the between-subject variables. There was a significant main effect of the pieces over the four synthetic variables (F (8, 31) = 57·97; $p < \cdot 001$), as for each synthetic variable. Planned comparisons indicated that ratings differed significantly between Schönberg and Mozart (F (4, 35) = 108·35; $p < \cdot 001$) between Schönberg and Bach (F (4, 35) = 49·5; $p < \cdot 001$) and between Bach and Mozart (F (4, 35) = 28·9; $p < \cdot 001$). As shown in Figure 1, the meanings evoked by each piece were clearly distinct. Mozart evoked more positive feelings than Bach and Schönberg (synthetic variable 1) while the Schönberg piece evoked greater feelings of dynamism than did Mozart and Bach pieces (synthetic variable 2). The Schönberg piece, however, was judged as more "bizarre and mysterious" than those of Bach and Mozart (synthetic variable 4).

The effect of Version was significant over the four synthetic variables together (F (4, 35) = 4·87; $p < \cdot 01$), but not on each of the synthetic variables when considered for the Schönberg piece (F (4, 35) = 4·2; $p < \cdot 01$). Version was not significant for either the Bach piece (F (4, 35) = ·64) or the Mozart piece (F (4, 35) = 1·65). The interaction between the factors Piece and Version was not significant (F (8, 31) = 1·14). As shown in Figure 2, the effect of Version appeared to be very small even for the Schönberg piece, notably when compared with the large effect of the Piece factor. Indeed about 97% of the experimental variance was explained by the Piece factor alone on each synthetic variable.

Univariate analyses of variance were also performed for each of the semantic scales (Table 2). The effect of the Piece factor was always significant. Moreover, planned comparisons indicated that the subjects' ratings differed significantly from Mozart to Bach for all semantic scales except one (number 18) and from Mozart to Schönberg for all semantic scales. Significant differences in subjects' ratings were observed between the Bach and Schönberg pieces for most of the semantic scales except scales 4, 6, 11, 12, 14, and 23. The effect of Version was significant for only two semantic scales (numbers 21 and 26) and the Piece x Version interaction was significant for the 26th semantic scale. These univariate analyses therefore strengthened the outcomes of previous analyses: the Piece factor had

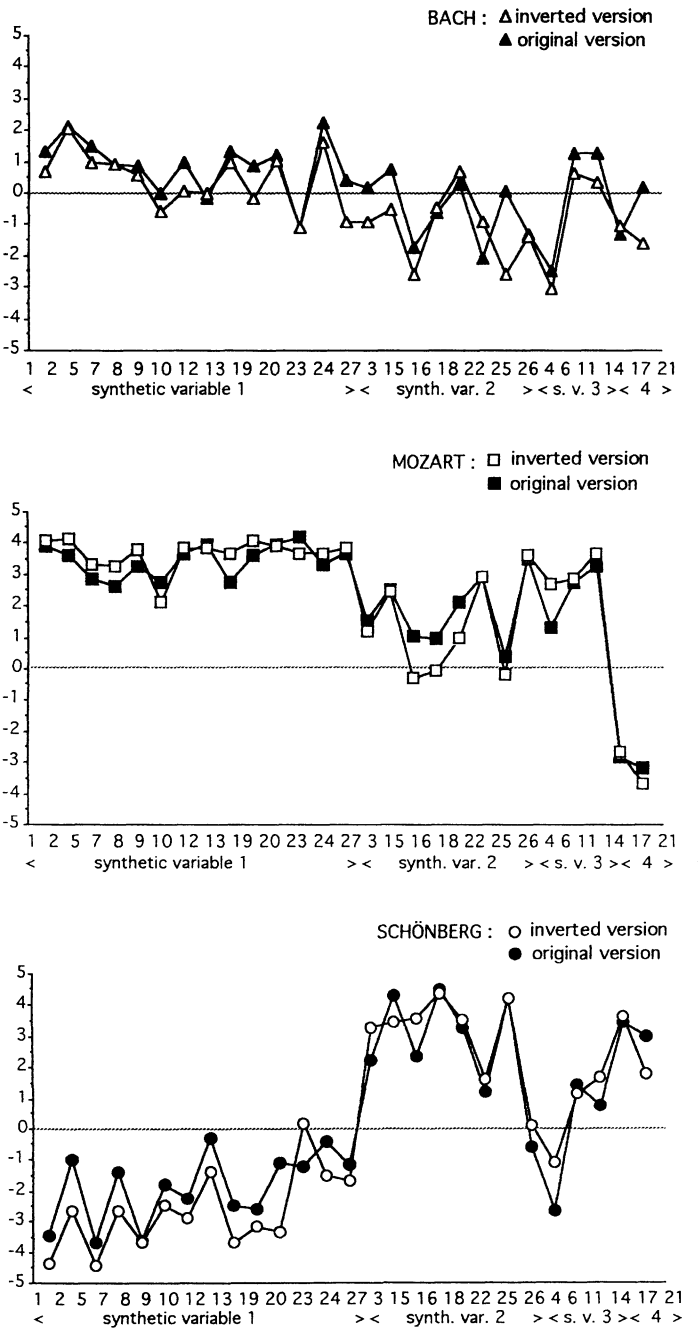

FIG. 3

Mean ratings on the 29 bipolar scales for each version of the Bach (top), Mozart (middle) and Schönberg (bottom).

a very strong effect upon the subjects' ratings, but the Version factor did not. As shown in Figure 3, most of the average ratings recorded over the 27 semantic scales were very similar in both the original and the inverted versions.

A second 3 × 2 MANOVA was performed with the "expressivity" and "coherence" scales as the dependent variables. The outcome was similar. There was a highly significant effect of Piece (F (4, 35) = 29·9; $p < ·001$), but neither the Version effect (F (2, 37) = 1·29) nor the Piece–Version interaction (F (4, 35) = 1·54) were significant. Planned comparisons performed on the Piece factor on the two dependent variables indicated that subjects' ratings differed significantly between Schönberg and Mozart (F (2, 37 = 43·32; $p < ·001$), between Schönberg and Bach (F (2, 37 = 58·66; $p < ·001$), and between Bach and Mozart (F (2, 37 = 72·92; $p < ·001$). As shown in Figure 4, all the three pieces were considered as expressive, with Mozart more expressive than either Schönberg or Bach. The Bach and Mozart were judged as coherent and the Schönberg as incoherent. Playing the chunks in a backward order did not significantly alter the subjects' judgements.

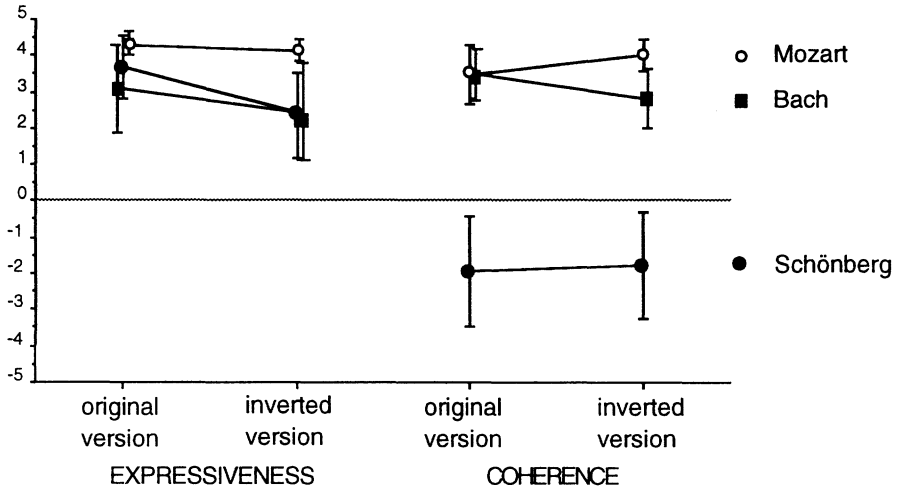

FIG. 4

The 95% confidence intervals of average ratings of expressiveness and coherence for each piece and each version.

Playing the chunks backwards or forwards clearly had a weaker effect on ratings of expressiveness than was previously assumed. The extent to which the strong modifications, present in the inverted versions of the pieces, were even noticed by the listeners is questionable. At the end of the experiment, the subjects were informed about the modifications performed in the pieces, and were then required to identify which version (original or inverted) they had listened to. In the original version, 77% of the subjects responded correctly. Only 43% of subjects who listened to the inverted version identified it as such. Only the subjects in the original version performed above chance level ($p < ·05$).

Discussion

In the present experiment, non-musician listeners were required to rate musical expressiveness and coherence of three piano pieces on 29 bipolar semantic scales. The pieces played were from the baroque and classical periods of Western tonal music, and twelve tone Western music. These pieces were segmented into short chunks that were linked in a forward order (original version) or in a backward order (inverted version). Half of the subjects listened to the original version, the other half to the inverted version. The data provided evidence that these pieces (whichever version was played) provoked strong differences in perceived expressiveness. On the contrary, the experiment did not support there being a strong effect due to the version. Notably, it appears that linking the Bach and the Mozart chunks in a backward order did not provoke significant changes in the expressiveness ratings. Moreover, feelings of coherence and expressivity did not significantly decrease for the inverted versions. Finally, the only piece for which some significant effect of the version was observed, that of Schönberg, was the least formally structured of all the pieces. However, even for this piece, the effect of version was weak and accounted for a very small part of the experimental variance.

The present findings suggest that the structural relations (motivic and harmonic) that exist beyond the chunks did not strongly contribute to musical expressiveness and perceptual coherence for non-musically trained listeners. Moreover, even when informed about the modifications performed in the musical pieces, the subjects did not understand above chance level that they had listened to the inverted versions of the musical pieces. These findings were unexpected but are strongly consistent with those reported by Konečni (1984), Gotlieb and Konečni (1985), Cook (1987) and Karno and Konečni (1992). All of these studies have provided evidence that large musical structure has only a weak effect on perceived musical expressiveness. From this point of view one may consider musical sequences as very different from linguistic stimuli. Indeed, it has been shown that similar modifications to the order of sentences strongly decrease the comprehension of narrative text (Garnham, Oakhill and Johnson-Laird, 1982; Ohtsuka and Brewer, 1992). Because narrative text refers to an external reality, re-ordering the sentence in a text causes incongruence between the organisation of *event structures* in the real world, and the arrangement of these events in the text (*discourse structure*). In contrast, music does not refer to any external reality. Therefore re-ordering the small chunks of an unknown musical piece may not strongly affect listeners.

If large musical structures only contribute weakly to the perception of musical expressiveness, (for non-musician listeners at least), what is it that causes musical expressiveness and perceptual coherence? It has been shown that very short musical excerpts (even as short as three seconds) contain enough information to determine specific musical expressiveness (Imberty, 1979, 1981; Nielzen and Czesarec, 1981; Nielzen and Olsson, 1993). The present study has provided further evidence of the importance of local information, even when considering longer musical pieces with a global form. Indeed, that two independent groups of subjects provided similar patterns of ratings for both the original and inverted versions suggests that the information contained in the musical chunks was sufficient to determine the content of musical expressiveness. The global form would contain no, or nearly no, further information regarding musical expressivity. The present

experiment was not designed to address which kinds of local features (superficial or structural ones) were responsible for the subjects' responses. Nevertheless, we may reasonably assume that those rhythmic, melodic, dynamic, or local harmonic patterns that were the most frequent in the pieces may have influenced ratings of musical expressiveness. Furthermore, the repetition of local patterns in several chunks of the pieces could also have been sufficient to confer perceptual coherence upon the inverted versions.

Conclusion

The present experiment failed to support a strong link between large formal structure and perceived musical expressiveness for non-musically trained listeners. This result does not necessarily mean that non-musicians are definitely unable to process large formal relationships. The present experiment indicated that when required to focus on musical expressiveness, non-musician listeners mainly react to the local structures inside the chunks. Of course, the present findings are restricted to the non-musically trained community. Batt (1987) underlines the importance of listeners' familiarity with classical period music which "relies heavily on the listeners' hearing of the subtleties of its structure, on the listeners' ability to read the code of the music" (p. 212); this suggests that the data would have been different if the listeners had been more knowledgeable. But further studies on perception of musical form or of large-scale tonal structures showed same kind of results as the present study for musically sophisticated listeners (Cook, 1987; Konečni, 1987; Karno and Konečni, 1992). We may also wonder what would have been the effect if the inverted version of the pieces, unknown at the beginning of the experiment for the subjects, had been played more than twice. As noted by Jackendoff (1991), repeated listening probably increases the importance of the large formal structure on musical expressiveness. Nevertheless, even taking into account these two limitations, the present findings indicate that the perceptual reality of large formal structures may be less evident than generally assumed. Studies in cognitive psychology have shown that at least in short and simple musical sequences hierarchical structures of a musical stimuli had a psychological reality for listeners, also for non-musician ones (*i.e.*, Bigand, 1990; Platt and Racine, 1994; Cuddy and Thompson, 1992; Boltz, 1989). But the hierarchical encoding assumption has been challenged by a set of provocative results obtained with longer and more complex musical sequences (Cook, 1987; Konečni, 1984; Gotlieb and Konečni, 1985; Karno and Konečni, 1992). This is a challenging contradiction that is worth further investigation in future research. For now, the present study poses the following disturbing question: if one day a silly conductor decides to play a piece of music, re-ordering small chunks in the way we did, how many of those people who regularly attend classical music concerts would notice that something is amiss?

References

Batt, R. (1987). Comments on "The effects of instrumentation, playing style, and structure in the Goldberg Variations by Johann Sebastian Bach". *Music Perception*, **5** (2), 207–213.

Bharucha, J. J. and Stoeckig, K. (1986). Reaction time and musical expectancy: priming of chords. *Journal of Experimental Psychology: Human Perception and Performance*, **12,** 1–8.

Bigand, E. (1990). Abstraction of two forms of underlying structure in a tonal melody. *Psychology of Music*. **18,** 45–59.

Bigand, E. (1993). Contributions of music to research on human auditory cognition. In: S. McAdams & E. Bigand (Eds.), *Thinking in Sound: The cognitive psychology of human audition*. Oxford: Clarendon Press, pp. 231–277.

Boltz, M. (1989). Perceiving the end: Effects of tonal relationships on melodic completion. *Journal of Experimental Psychology: Human Perception and Performance,* **15,** 749–761.
Boltz, M. (1993). The generation of temporal and melodic expectancies during musical listening. *Perception and Psychophysics,* **53,** 585–600.
Caspy, T., Peleg, E., Schlam, D. and Goldberg, J. (1988). Sedative and stimulative music effects. *Motivation and Emotion,* **12,** 123–138.
Cook, N. (1987). The perception of large-scale tonal closure. *Music Perception,* **5** (2), 197–206.
Cuddy, L. and Thompson, W. (1992). Asymmetry of perceived key movement in chorale sequences. *Psychological Research,* **54,** 51–59.
Deutsch, D. and Feroe, J. (1981). The internal representation of pitch sequences in tonal music. *Psychological Review,* **88,** 503–522.
Dowling, W. J. (1972). Recognition of melodic transformations: Inversion, retrograde and retrograde–inversion. *Perception and Psychophysics,* **12,** 417–421.
Dowling, W. J. and Harwood, D. L. (1986). *Music cognition.* Orlando: Florida Academic Press.
Fraisse, P. (1957). *Psychologie du temps.* Paris: PUF.
Fraisse, P. (1992). *Des mots et des choses: La prise d'information.* Pris: PUF.
Francès, R. (1958). *La perception de la musique.* Paris: Vrin. (2° édition, 1984).
Garnham, A., Oakhill, J. and Johnson-Laird, P. N. (1982). Referential continuity and the coherence of discourse. *Cognition,* **11,** 29–46.
Gotlieb, H. and Konečni, V. J. (1985). The effects of instrumentation, playing style, and structure in the Goldberg Variations by Johann Sebastian Bach. *Music Perception,* **3,** 87–102.
Gottesdiener, H. (1969). Problème de la signification. Utilisation du différenciateur sémantique en esthétique expérimentale. *Sciences de l'Art,* **1–2,** 38–45.
Griffiths, P. (1978). *Histoire concise de la musique moderne.* Paris: Fayard.
Hevner, K. (1936). Experimental studies in the elements of expression in music. *American Journal of Psychology,* **48,** 246–268.
Hodeir, André (1951). *Les formes de la musique.* (12° édition, 1993). Que sais-je? Paris: PUF.
Imberty, M. (1978). *Sémantique psychologique de la musique.* Thèse de doctorat des Lettres et Sciences Humaines. Universite de Paris X, Nanterre.
Imberty, M. (1979). *Entendre la musique: Sémantique psychologique de la musique,* Vol. 1. Paris: Dunod.
Imberty, M. (1981). *Les écritures du temps: Sémantique psychologique de la musique,* Vol. 2. Paris: Dunod.
D'Indy, V. (1897). *Cours de composition musicale.* Paris: Durand et fils.
Jackendoff, R. (1991). Musical parsing and musical affect. *Music Perception,* **9,** 199–230.
Jones, M. R. (1987). Dynamic pattern structure in music: recent theory and research. *Perception and Psychophysics,* **41,** 621–634.
Karno, M. and Konečni, V. J. (1992). The effects of structural interventions in the first movement of Mozart's Symphony in G-Minor, K. 550, on aesthetic preference. *Music Perception,* **10,** 63–72.
Konečni, V. J. (1984). Elusive effects of artists' "messages". In: W. R. Crozier & A. J. Chapman (Eds.), *Cognitive processes in the perception of art.* Amsterdam: North-Holland. pp. 71–96.
Krumhansl, C. L. (1990). *Cognitive foundations of musical pitch.* Oxford: Oxford University Press.
Krumhansl, C., Sandell, G. and Sergeant, D. (1987). The perception of tone hierarchies and mirror forms in the twelve tone serial music. *Music Perception,* **5,** 31–78.
Lerdahl, F. (1989). Structure de prolongation dans l'atonalité. In: S. McAdams & I. Deliège (Eds.), *La musique et les sciences cognitives.* Liège: Mardaga, pp. 171–179.
Lerdahl, F. (1991). Pitch-space journeys in two Chopin Preludes. In: M. R. Jones & S. Holleran (Eds.), *Cognitive bases of musical communication,* A.P.A., pp. 171–191.
Lerdahl, F. and Jackendoff, R. (1983). *A generative theory of tonal music.* Cambridge: MIT Press.
McAdams, S. (1988). Contraintes psychologiques sur les dimensions porteuses de forme en musique. In: S. McAdams & I. Deliège (Eds.), *La musique et les sciences cognitives.* Liège: Mardaga, pp. 257–284.
Meyer, L. B. (1956). *Emotion and meaning in music.* Chicago: University of Chicago Press.
Meyer, L. B. (1973). *Explaining music: Essay and exploration.* Berkeley: University of California Press.
Nielzen, S. and Cesarec, Z. (1981). On the perception of emotional meaning in music. *Psychology of Music,* **9,** 17–31.
Nielzen, S. and Olsson, O. (1993). The influence of duration on verbal-attribute ratings of complex protomusical sound. *Music Perception,* **11,** 73–86.

Ohtsuka, K. and Brewer, W. F. (1992). Discourse organisation in the comprehension of temporal order in narrative texts. *Discourse Processes,* **15,** 317–336.
Osgood, C. E., Suci, G. J. and Tannenbaum, P. H. (1957). *The measurement of meaning.* Urbana: University of Illinois Press.
Peirce, C. S. (1931–1935). *Collected papers,* (Vols. 1–6), Hartshorne, S. & Weiss, P. (Eds.), Cambridge, MA: Harvard University Press.
Platt, J. and Racine, R. (1994). Detection of implied harmony changes in triadic melodies. *Music Perception,* **3,** 243–264.
Schenker, H. (1979). *Free composition,* (transl. from German by E. Oster, 1935), New York: Longman.
Scherer, K. R. and Oshinsky, J. S. (1977). Cue utilisation in emotion attribution from auditory stimuli. *Motivation & Emotion,* **1,** 331–346.
Schmuckler, M. A. (1989). Expectation in music: Investigation of melodic and harmonic processes. *Music Perception,* **7,** 109–150.
Sloboda, J. (1985). *The musical mind: The cognitive psychology of music.* Oxford: Oxford University Press.
Sloboda, J. (1991). Music structure and emotional response: some empirical findings. *Psychology of Music,* **19** (2), 110–121.
Tranchefort F.-R. (1987). *Guide de la musique de piano.* Paris: Fayard.
Vuillermoz, E. (1973). *Histoire de la musique.* Paris: Fayard.