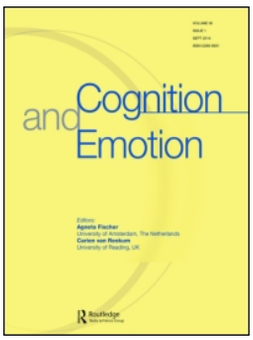

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Mode and tempo relative contributions to ''happy-sad'' judgements in equitone melodies

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Judgement of emotion conveyed by music is determined notably by mode (major-minor) and tempo (fast-slow). This suggestion was examined using the same set of equitone melodies, in two experiments. Melodies were presented to nonmusicians who were required to judge whether the melodies sounded ''happy'' or ''sad'' on a 10-point scale. In order to assess the specific and relative contributions of mode and tempo to these emotional judgements, the melodies were manipulated so that the only varying characteristic was either the mode or the tempo in two ''isolated'' conditions. In two further conditions, mode and tempo manipulations were combined so that mode and tempo either converged towards the same emotion (*Convergent condition*) or suggested opposite emotions (*Divergent condition*). The results confirm that both mode and tempo determine the ''happy-sad'' judgements in isolation, with the tempo being more salient, even when tempo salience was adjusted. The findings further support the view that, in music, structural features that are emotionally meaningful are easy to isolate, and that music is an effective and reliable medium to study emotions.

Emotional processing of music is a largely neglected area of investigation in current experimental psychology (for reviews, see Juslin, 1997, and Krumhansl, 1997). This is unfortunate as music is essentially conceived as an emotional medium acting as a social cohesive force (Dowling & Harwood, 1986; Sloboda, 1985). With this view, the major reason for the existence of music in human societies is likely to be related to its emotional roots. The lack of investigation can be attributed to the widely held belief that emotional interpretation of music is a highly personal and variable experience, hence escaping scientific

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examination. However, some authors, including ourselves (see below), have demonstrated that emotional responses to the music of one's own culture rely on the computation of several and relatively elaborate properties (as for emotional responses to speech; e.g., see Scherer, 1991) and are relatively homogeneous across individuals, being shared by all members of that culture.

When subjects are given checklists of emotional adjectives to be assigned to musical excerpts, their responses are systematic (Cunningham & Sterling, 1988; Gundlach, 1935; Krumhansl, 1997; Rigg, 1937b; Robazza, Macaluso, & D'urso, 1994; Terwogt & Van Grinsven, 1991). Listeners also easily identify the intended emotion conveyed through the manipulation of different patterns of cues (such as tempo, loundness, etc.), in simple melodies composed by professional musicians (Thompson & Robitaille, 1992) or in well-known melodies played by professional musicians (Juslin, 2000), so as to communicate specific emotions. Such consistency in emotional evaluation can be found very early during development (Cunningham & Sterling, 1988; Dalla Bella, Peretz, Rousseau & Gosselin, 2001; Kastner & Crowder, 1990; Terwogt & Van Grinsven, 1991). Children as young as 3 years old are able to discriminate happy from sad musical excerpts (Kastner & Crowder, 1990).

Besides, we have suggested that emotional judgement of music may be spared in the presence of a lost ability to process nonemotional musical information. We investigated a patient with longstanding bilateral damage to the brain, who could no longer classify melodies as ''familiar'' or ''unfamiliar'', while she was still able to classify these same melodies as ''happy'' and ''sad'' (Peretz & Gagnon, 1999). Accordingly, the study of emotional processing of music might be of a particular interest in the study of a possible functional dissociation between cognition and emotion.

The easiest emotions to communicate through music tend to be happiness and sadness (Gabrielsson & Juslin, 1996; Krumhansl, 1997). Moreover, these emotions are easy to convey through variations of two musical characteristics: mode and tempo. Mode is related to the subset of pitches selected in a given musical segment. In major mode, the intervals between the 1st and 3rd and between the 1st and 6th pitches are larger by one semitone than in the minor mode. Musical excerpts written in the major or minor mode are typically judged to be happy or sad, respectively (Gerardi & Gerken, 1995; Hevner, 1935; Peretz, Gagnon & Bouchard, 1998a; Rigg, 1937a, 1939; Scherer & Oshinsky, 1977). Musical excerpts that have a fast or slow tempo (that contain many or few beats per minute, respectively) are also judged to be happy or sad, respectively (Gundlach, 1935; Hevner, 1937; Peretz et al., 1998a; Rigg, 1937a, 1940; Watson, 1942).

Hevner (1935) was the first to experimentally demonstrate the role of mode characteristics in the classification of musical excerpts as being happy or sad. She presented 10 short excerpts from the classical repertoire which were each played in both major and minor mode with all other factors being held constant.

Subjects were asked, on a first hearing, to choose as few or as many of 84 suggested adjectives (e.g., melancholy) which would best describe the music, and, on a second hearing, to select one from 16 opposite adjectives (e.g., happy-sad, serious-light). The main results ''confirmed the historically affirmed characteristics of the two modes'' (p.118), because happiness was more often selected when the piece was played in the major mode and sadness, when the piece was played in the minor mode. These judgements were found to be independent of musical training. Tempo was considered later by Hevner (1937) in eight excerpts (which were different from the ones used in the previous study), each being played either in a slow (between 63 and 80 metronome marking—M.M.) or fast (between 102 and 152 M.M.) tempo. Results were consistent with the role of tempo characteristics for the emotional classification of musical excerpts as the happy adjective was more often assigned to the fast excerpts, and the serene (rather than sad) adjective to the slow excerpts. Rigg (1939, 1940) essentially replicated these results while using the same set of novel melodies for assessing mode and tempo.

Rigg (1964) concluded, although he did not assess it statistically, that ''tempo is the most important feature in determining the mood effects of music'' (p.435). Similarly, Hevner (1937) concluded that from all the variables that she previously investigated, tempo is ''of greatest importance in carrying the expressiveness in music. [...] Modality [mode] is perhaps second in importance'' (p.625). More recently, Scherer and Oshinsky (1977) reached similar conclusions. However, none of these studies assessed the specific contribution of mode and tempo for the same selections and/or by the same subjects. In one of our neuropsychological studies (Peretz et al., 1998a), we used musical excerpts in which the influence of mode and tempo was measured in isolation and in combination so as to assess their respective contribution to happy-sad distinction. No tempo supremacy was observed. However, real and complex musical excerpts were used and other structural characteristics may have masked a tempo supremacy in regard to mode. Moreover, the relative contribution of mode and tempo has not yet been assessed. Thus, the idea that tempo would be more fundamental than mode in conveying the ''happy-sad'' distinction has not yet received empirical support.

The present study aimed at verifying the specific contribution of mode and tempo to the happy-sad distinction in highly controlled melodies (in comparison to melodies used in our previous study; Peretz et al., 1998a). Additionally, the relative contribution of mode and tempo to these judgements was assessed.

With this aim, we generated very simple melodies and manipulated the mode and the tempo in which they were presented to the listeners. Their task was to judge whether the melody sounded happy or sad on a 10-point rating scale. In order to avoid contamination of these judgements by explicit knowledge of musical rules, only nonmusicians participated in the study. They performed happy-sad judgements under four different conditions. In two conditions,

hereafter referred to as isolated conditions, mode and tempo were manipulated separately. In the mode condition, the melodies were either written in major and minor modes (both consisting of unequal-step scales), or in a whole tone scale mode. The latter, structured on the basis on an equal-step scale, establishes neither a major or minor mode and is accordingly considered relatively neutral. Tempo was set to a neutral value (165 M.M.) and kept the same across melodies. In the tempo condition, the tempo of melodies was either fast (220 M.M.), slow (110 M.M.), or intermediate (165 M.M.), and the whole tone mode was used across the melodies. These two isolated conditions served to establish that mode and tempo were each appropriately set to determine, in isolation, the intended happy or sad judgement.

In order to assess the relative contributions of mode and tempo to the same judgements, they were jointly manipulated in two further conditions, hereafter referred to as the combined conditions. In one condition, the convergent condition, the tempo and mode characteristics of each melody were selected so that they converged onto the same intended emotion. Thus, in that condition, one third of the sequences were written in the major mode and played at a fast tempo, another third were minor and slow, and the remaining third in the whole tone mode in combination with an intermediate tempo. In the other combined condition, so-called divergent condition, the tempo and mode characteristics were chosen so as to elicit opposite emotions. In this latter condition, one-third of the melodies were both major and slow, the other third were minor and fast, while the remaining third remained neutral in this respect, being written in a whole tone scale mode at an intermediate tempo. The two isolated and the two combined conditions were presented in a counterbalanced order to the same subjects.

The predictions were that if both mode and tempo jointly contribute to the happy-sad judgements of the melodies, then the ratings should be more extreme in the convergent condition than in the isolated conditions. Conversely, in the divergent condition, the ratings should be less extreme than in the isolated conditions. If tempo, however, is more determinant than mode for emotional classification of the melodies, as the literature suggests, then the ratings should reflect the main influence of tempo characteristics in both combined conditions.

EXPERIMENT 1

Method

Subjects. A total of 16 subjects (8 women and 8 men) having a mean age of 24.6 years (range: 20–35) were recruited mostly from the university community. They were considered nonmusicians; 12 of them had no formal nor instrument experience and the remaining four subjects had less than three years of musical practice.

Stimuli and material. Eight tone sequences were constructed in C major. Each sequence began with a differing five-note pattern, which contained tones of equal duration except for the last one, which was twice as long. Each pattern started on the first degree of the scale and ended on the 5th degree. To form a full sequence, the pattern was presented twice, except for the last tone which was changed so that the whole sequence ended on the first degree (see the first example in Figure 1). Repetition of the pattern aimed at establishing a sense of key more firmly, while limiting short-term memory requirements. Because the 3rd and 6th degrees of the scale establish the difference between the major and minor modes, they were both included in each sequence. In order to create a minor version of the eight major mode sequences, the critical 3rd and 6th degrees of the scale were lowered by a semitone (i.e., from E to E flat and from A to A flat). Whole tone mode versions of these eight major/minor sequences were also created, in order to represent neutrality. To do so, the pitches were changed so as to conform to the whole tone scale while keeping the same starting pitch and pitch contour as the major and minor sequences. We thought that whole tone scale mode may represent neutrality as it is used in few compositions of widespread music (compared to the use of major and minor modes). Confirmed neutrality of the sequences was obtained through several pilot studies. The three versions of one sequence are represented in Figure 1. There were 24 different sequences, with 8 in each mode.

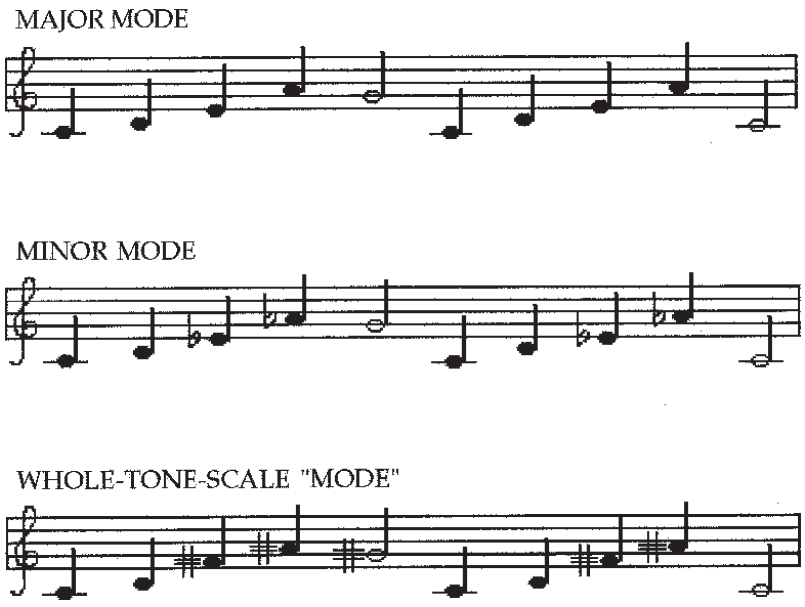

Figure 1. Example of a C major mode sequence and its minor and whole tone scale mode versions.

The tempo values that were used were 220, 165, and 110 M.M.: note duration corresponded to 272 ms in the fast tempo, 363 ms in the moderate tempo, and 544 ms in the slow tempo. These tempo values were selected after several pilot studies. It is interesting to note that, according to Fraisse (1982) definition of the ''prefered tempo'', which would be neither too slow or too fast and which would be close to 500 ms, these values would actually fall into the moderate to fast range of tempi. In the present study, tempo values are said to be fast and slow in relation to one another and in relation to what emotion they communicate. Different combinations of melodic sequences and tempi served as stimuli in the four different conditions. In the Mode isolated condition, the 24 melodic sequences were each played at the moderate tempo (165 M.M.). In the Tempo isolated condition, the eight whole tone mode sequences were each played at the three different tempi. In the convergent combined condition, the major sequences were played at the fast tempo, the minor mode sequences at the slow tempo, and the whole tone mode sequences at the moderate tempo. In the divergent combined condition, major sequences were played at the slow tempo, minor sequences at the fast tempo, and whole tone mode sequences at the moderate tempo. It is worth noting that the whole tone mode sequences played at the moderate tempo were the only stimuli used in all conditions.

In each condition, there were 24 different sequences, which were repeated once in a different order. The 48 sequences per condition were recorded in a random order. Fast random sequences of 11 pitches of 75 ms each were added between the sequences. These served as distractors, following Bharucha and Stoekig's (1987) procedure to ''erase'' tonal memory.

All stimuli were generated by a Yamaha TX-81Z synthesiser, controlled by an IBM-compatible computer. The analogue output was pre-set to a timbre imitating the sound of a pan flute, and was recorded with an Aiwa stereo cassette deck XK-009. The tapes were played back to the subject via a portable cassette deck at a comfortable listening level.

Procedure. Subjects first responded to a questionnaire intended to determine their musical background and were then assigned to one of the four presentation orders in one of the four conditions, following a latin square. Female and male subjects were assigned to the same order in equal number. They were instructed to judge whether each musical sequence was expressing happiness or sadness on a 10-point rating scale, with 1 meaning happy and 10, sad. Before each condition, 12 practice trials (illustrating all possible versions) were presented and repeated once in a different order. No further information or feedback was provided to the subjects and they were told that there was no right or wrong answer. Subjects were individually tested in a session lasting about 60 min, and were paid for their participation.

Results and comments

The mean ratings obtained for each type of sequence in each condition are presented in Table 1. These ratings were submitted to separate ANOVAs, considering either subjects as the random variable (F_1) or items as the random variable (F_2). The intended Emotion (happy, neutral, or sad) was the within-subjects and within-items factor. For the *Divergent* condition, intended Emotion could not be determined a priori. As the mean ratings are indicative of reliance on tempo more than mode, the Emotion factor was set according to presumed emotion conveyed by tempo, as is clarified below.

Two preliminary analyses of variance were performed to assess potential effects of Order and Sex on the variables of interest (considering subjects as the random variable). To assess the influence of Sex, an ANOVA was performed on the ratings by considering Condition (Mode vs. Tempo vs. Convergent vs. Divergent) and Emotion as the within-subjects factors and Sex (female vs. male) as the between-subjects factor. No main effect or interaction involving Sex was

TABLE 1
Mean ratings obtained for each type of sequence and intended emotion as a function of Condition in Experiments 1 and 2

	Intended Emotion	*Ratings*	
		Exp. 1	*Exp. 2*
Isolated component conditions			
Mode condition			
major mode/moderate tempo	Happy	4.69	4.55
w-t-s mode/moderate tempo	Neutral	5.05	5.57
minor mode/moderate tempo	Sad	6.53	6.71
Tempo condition			
fast tempo/w-t-s mode	Happy	3.41	3.75
moderate tempo/w-t-s mode	Neutral	4.88	5.46
slow tempo/w-t-s mode	Sad	7.24	7.27
Combined components conditions			
Convergent condition			
major mode/fast tempo	Happy	2.85	3.19
w-t-s mode/moderate tempo	Neutral	4.94	5.58
minor mode/slow tempo	Sad	7.88	7.92
Divergent condition			
minor mode/fast tempo	–	3.93	4.82
w-t-s mode/moderate tempo	–	5.16	5.38
major mode/slow tempo	–	7.04	6.46

Note: w-t-s, whole tone scale.

obtained. Similarly, the ANOVA performed on the ratings with Emotion and Condition as within-subjects factors and presentation Order (order 1 vs. 2 vs. 3 vs. 4) as the between-subjects factor did not reveal any significant effect of Order nor interaction with the other variables. Therefore, Sex and Order of presentation effects were considered negligible and were not further examined in the following analyses.

As can be seen in Table 1, ratings were clearly differentiated according to the intended emotion in each condition. To assess the isolated influence of mode and tempo characteristics on the ratings statistically, separate ANOVAs were first performed in each isolated condition considering Emotion as the within-subjects and within-items factor. In the *Mode* condition, the analysis revealed a reliable effect of intended Emotion, $F_1(2, 30) = 15.25$, $MS_e = 1$; $F_2(2, 14) = 48.48$, $MS_e = 0.16$; both ps $< .001$. Major mode sequences were rated happier than minor mode sequences, $t(15) = -6.063$, by paired t-test computed across subjects, and $t(7) = -10.759$ across items; both ps $< .001$. However, major sequences were not judged happier than whole tone mode sequences, $t(15) = -0.884$, and $t(7) = -1.686$; both ps $> .05$. In the *Tempo* isolated condition, there was also a large effect of intended Emotion, $F_1(2, 30) = 79.62$, $MS_e = 0.75$; $F_2(2, 14) = 511.39$, $MS_e = 0.06$; both ps $< .001$. Fast sequences were rated happier than slow sequences, $t(15) = -9.286$ per subject, and $t(7) = -31.376$ per item; both ps $< .001$. Fast sequences were also rated happier than moderate sequences, $t(15) = -7.584$, and $t(7) = -13.624$; both ps $< .001$.

In order to assess statistically the possibility that tempo may be more salient than mode in determining the emotional judgements when considered in isolation, an analysis of variance comparing the two isolated conditions was carried out. This combined ANOVA yielded an interaction between Condition and intended Emotion, $F_1(2, 30) = 9.60$, $MS_e = 0.82$, $p < .01$; $F_2(2, 14) = 28.99$, $MS_e = 0.13$; $p < .001$. This reflects the fact that the ratings were more extreme in the *Tempo* condition than in the *Mode* condition.

To assess the joint contribution of tempo and mode to the judgements, separate ANOVAs were first performed in each combined condition and then compared to the *Tempo* isolated condition in an overall analysis. In the *Convergent* condition, as expected, a clear effect of intended Emotion was obtained, $F_1(2, 30) = 103.08$, $MS_e = 0.99$; $F_2(2, 14) = 1001.61$, $MS_e = 0.05$; both ps $< .001$. This effect was found to be reliably different from the one obtained in the *Tempo* isolated condition, as the interaction between Condition and intended Emotion reached significance, $F_1(2, 30) = 14.72$, $MS_e = 0.20$; $F_2(2, 14) = 19.00$, $MS_e = 0.08$; both ps $< .001$. Simple effects revealed more extreme ratings in the *Convergent* condition for both happy and sad judgements (all ps $< .05$, by Tukey*A post-hoc* comparisons). These results show that tempo is not the sole determinant of the happy-sad distinction in the convergent condition, the addition of mode information brings significantly more extreme ratings.

As can be seen in Table 1, the ratings observed in the *Divergent* condition appear less pronounced than in the *Tempo* condition, again suggesting an influence of mode information on the resulting judgement in the *Divergent* condition. To assess whether or not this apparent difference was statistically reliable, the ratings obtained in the *Divergent* condition were compared to those obtained in the *Tempo* isolated condition by a combined ANOVA. In order to examine this with results from the *Divergent* condition, the intended Emotion was set according to tempo variations, minor mode/fast tempo sequences being considered happy, and the major mode/slow tempo sequences being considered sad in the analysis. For the *Divergent* condition alone, a clear effect of tempo-related Emotion was obtained, $F_1(2, 30) = 30.10$, $MS_e = 1.27$; $F_2(2, 14) = 131.25$, $MS_e = 0.15$; both ps $< .001$. The interaction between Condition and tempo-related Emotion failed, however, to reach significance when subjects were considered as the random factor, with $F_1(2, 30) = 2.72$, $MS_e = 0.39$, $p < .10$, but, with $F_2(2, 14) = 4.09$, $MS_e = 0.13$, $p < .05$. Thus, the results suggest that, in the presence of conflicting information, subjects tend to rely more on tempo information than on mode in their judgements.

Discussion

The experiment provides compelling evidence for the contribution of mode and tempo characteristics to happy-sad judgements. The results thus confirm previous studies (Hevner, 1935, 1937; Peretz et al., 1998a; Rigg, 1939, 1940), which show that major mode and fast tempo convey happiness to melodies and minor mode and slow tempo convey sadness. Each musical characteristic alone was found to influence emotional judgement. When combined so as to evoke the same emotion, the impact of mode and tempo is clearly stronger. However, tempo seems to be more effective in determining the happy-sad distinction than mode. Subjects were more prone to give extreme ratings when tempo was the only varying dimension than when mode was the only discriminant cue. Moreover, when mode and tempo were cueing conflicting emotions, such as when the melody was major but presented slowly, subjects gave ratings that were consistent with the tempo information, but not the mode. Therefore, the results support the hypothesis that Hevner (1937) and Rigg (1964) formulated some 50 years ago, that although mode contributes to happy-sad judgements, tempo is the greater determinant.

This conclusion should be taken cautiously. Mode manipulation and tempo manipulation do not follow the same metrics. Mode manipulation obeys the strict rules of the Western tonal system while tempo variation lies on a continuum. Thus, the observed predominance of tempo over mode may be due to a difference in parameter settings. Although the selected tempi were carefully selected after several pilot studies, it may still be the case that the chosen values are not equivalent to the mode changes in terms of relative salience. The ratings

obtained in the isolated conditions suggest that tempo was indeed more salient. This difference in the baseline conditions may explain the supremacy of tempo in the divergent condition. In other words, subjects would not systematically choose tempo as the basis for the happy-sad distinction, they would just pick out the most salient dimension. This possibility was assessed in Experiment 2 by decreasing the tempo difference between the happy and sad sequences.

EXPERIMENT 2

The purpose of Experiment 2 was to equate the saliency of tempo with regard to mode so as to revisit the predominance of tempo over mode in determining the emotional judgement of simple melodies observed in the first experiment. In order to do this, the tempo difference between the happy and sad sequences was decreased. A secondary goal was to reassess a possible gender difference. It has been widely demonstrated that females are superior to males at identifying affect from nonverbal cues such as those expressed by faces, body, and voices (for a review, see Brody & Hall, 1993). This gender difference has also been reported once in the domain of music (Cunningham & Sterling, 1988). Hence, twice the number of female and male subjects that were used in the first experiment were recruited for Experiment 2.

Method

The method was identical to the one used in Experiment 1 except for the number of subjects recruited, which was doubled, and the tempo values of stimuli which were set between 110 and 160 (instead of between 110 and 220 M.M.).

Subjects. A total of 32 subjects (14 women and 18 men) having a mean age of 23.4 years (range: 18–33) were recruited from the university community. They were also considered nonmusicians, following the same criteria as used in Experiment 1.

Stimuli. The tempo values used were 160, 135, and 110 M.M.: note duration was 374 ms in the fast tempo, 443 ms in the moderate tempo, and 544 ms in the slow tempo. These tempi were chosen on the basis of the results obtained by 10 pilot subjects who gave the mean ratings of 4.56, 5.10, and 5.78 for, respectively, the intended happy, neutral and sad sequences of the new tempo condition. Note that these ratings are close to those obtained in the mode condition of Experiment 1.

Results and comments

Two preliminary analyses of variance were performed to assess potential effects of Order of presentation of the four conditions and Sex (considering subjects as the random variable). The ANOVA performed to assess the influence of Sex

again failed to reveal a main effect of Sex and interaction with the other factors. Females provided more distinct responses than males on some occasions, but the difference never reached statistical significance. Even when the subjects of Experiment 1 and 2 were grouped, and a comparison of the two isolated conditions (Mode and Tempo) performed, we did not obtain any gender differences (see Table 2).

The Order of presentation of the four conditions did not influence ratings either, as the ANOVA did not reveal any significant effect of Order nor interaction with the intended Emotion. Therefore, Sex and Order of presentation effects were not further examined in the following analyses.

As can be seen in Table 1, the ratings obtained in Experiment 2 are very similar to those obtained in Experiment 1. Therefore, the first set of analyses performed on the ratings obtained in Experiment 2 follow the same rationale as those used previously. In the *Mode* isolated condition, a reliable effect of intended Emotion was found again, $F_1(2, 62) = 34.17$, $MS_e = 1.09$; $F_2(2, 14) = 62.42$, $MS_e = 0.15$; both ps $< .001$. In the *Tempo* isolated condition, there was also a large effect of intended Emotion, $F_1(2, 62) = 94.11$, $MS_e = 1.05$; $F_2(2, 14) = 323.92$, $MS_e = 0.08$; both ps $< .001$. However, and contrary to expectations, ratings were more distinct in the *Tempo* isolated condition than in the *Mode* isolated condition, as revealed by the interaction between Condition and intended Emotion, $F_1(2, 62) = 9.44$, $MS_e = 0.79$; $F_2(2, 14) = 17.65$, $MS_e = 0.11$; both ps $< .001$.

As in Experiment 1, mode characteristics contributed to the judgements when combined with tempo variations. In the *Convergent* condition, a clear effect of

TABLE 2
Mean ratings (and standard deviations) obtained for each isolated condition and intended emotion as a function of subject gender (for grouped subjects from Experiments 1 and 2)

	Female (n = 22)	*Male* (n = 26)
Happy		
Mode	4.45 (1.33)	4.72 (1.05)
Tempo	3.53 (1.59)	3.73 (1.05)
Average	*3.99 (1.52)*	*4.22 (1.16)*
Sad		
Mode	6.62 (1.28)	6.68 (1.09)
Tempo	7.31 (0.99)	7.21 (1.02)
Average	*6.96 (1.18)*	*6.94 (1.08)*

intended Emotion was obtained, $F_1(2, 62) = 119.24$, $MS_e = 1.50$; $F_2(2, 14) = 643.33$, $MS_e = 0.07$; both ps $< .001$. This effect was found to be reliably different from the one obtained in the isolated *Tempo* condition, since the interaction between Condition and intended Emotion also reached significance, $F_1(2, 62) = 8.19$, $MS_e = 0.72$, $p < .01$; $F_2(2, 14) = 37.89$, $MS_e = 0.04$, $p < .001$.

Furthermore, as in Experiment 1, the ratings observed in the *Divergent* condition of Experiment 2 appear less pronounced than in the *Tempo* isolated condition, but this time, this difference was statistically significant. In the *Divergent* condition, the effect of tempo-related Emotion was present, $F_1(2, 62) = 9.42$, $MS_e = 2.36$; $F_2(2, 14) = 50.18$, $MS_e = 0.11$, both ps $< .001$. However, this effect was significantly smaller than the one obtained in the *Tempo* isolated condition, since the interaction between Condition and intended Emotion was significant, $F_1(2, 62) = 14.16$, $MS_e = 1.02$; $F_2(2, 14) = 34.80$, $MS_e = 0.10$, both ps $< .001$. Simple effects revealed more extreme ratings in the *Tempo* isolated condition than in the *Divergent* condition for the Happy melodies (both ps $< .05$, by Tukey*A post-hoc* comparisons) and for the Sad melodies (both ps $< .05$, by Tukey*A post-hoc* comparisons). These results show that, in the presence of conflicting information, subjects tend to rely more on tempo than on mode information, but not exclusively so. In order to assess whether or not we succeeded in decreasing the saliency of tempo with regard to mode in comparison to Experiment 1, an ANOVA comparing the *Tempo* isolated conditions of Experiment 1 and 2 was performed by considering the items as the random variable. This combined ANOVA yielded an interaction between Experiment and intended Emotion, $F_2(2, 14) = 11.71$, $MS_e = 0.03$, $p < .001$, hence supporting the idea that by decreasing the range of tempo values, tempo saliency will be diminished.

GENERAL DISCUSSION

In two experiments, compelling evidence for the determinant role of mode and tempo characteristics in the happy-sad distinction of music has been gathered. Tempo was found to be more determinant than mode in forming happy-sad judgements, despite changes of parameter settings in Experiment 2 so as to decrease its saliency. In conclusion, ratings obtained in Experiment 2 again clearly demonstrate the supremacy of tempo over mode in determining the happy-sad distinction, even though mode also contributes to the judgement.

However, we did not observe this tempo supremacy in our previous study using the same experimental setting with adults (Peretz et al., 1998a). Rather, we found that mode and tempo equally contributed to emotional judgements (Peretz et al., 1998a). In those studies, we used elaborate musical excerpts as they were selected from the pre-existing repertoire of art music. Moreover, as in the present study, we manipulated the mode and tempo characteristics so as to assess their respective contribution to the happy-sad distinction. As in the

present study, the mode was inverted from major to minor (and vice versa). Unlike in the present study, the tempo was set to a unique value, corresponding to the median value of all pre-existing tempi. Hence, the unique median value could be sometimes close to the original value, sometimes distant. The tempo variations were not systematic, as they depended to a great extent on the original tempo value of the excerpt considered. This was not the case here where tempo values were fixed and identical across excerpts. When systematically assessed in a highly controlled and simplified setting, tempo emerges as the most salient determinant of the happy-sad distinction.

Tempo saliency might be related to its similar function in domains other than music. For example, speech slows down during depression (e.g., Szabadi, Bradshaw, & Besson, 1976). In contrast, mode is music-specific. The use of particular pitch intervals is specific to music, and perhaps those used in major and minor modes are specific to the music of our culture. Tempo may also simply be easier to process than mode because every single event/note conveys relevant information through duration for tempo, whereas mode requires the use of more elaborate knowledge about pitch structure that is not conveyed by every single tone of the melody. For instance, mode perception often requires discrimination between one minor third (3 semitones) and a major third (4 semitones).

Supporting the idea that tempo may be only ''easier'' to process are results that we obtained with children (Dalla Bella et al., 2001). We observed that 5-year-old children exclusively used information about tempo to discriminate between happy and sad excerpts, whereas 6- to 8-year-olds, like adults, utilised both tempo and mode. These results supported the hypothesis that sensitivity to tempo precedes sensitivity to mode and are consistent with the idea that sensitivity to mode may be more dependent on learning, thus confirming prior studies showing late emergence of sensitivity to mode (Gerardi & Gerken, 1995; Gregory, Worral & Sarge, 1996). Despite mode being a ''secondary'' determinant of the happy-sad distinction, the results are quite impressive in that the subjects responded with clear sensitivity to mode differences that are generally difficult to hear by nonmusicians and even by musicians who are asked to make a nonemotional ''same-different'' classification task on melodies that could only differ by mode (Halpern, Bartlett, & Dowling, 1998). Perhaps the emotional judgements in the present study access implicit knowledge of mode more directly than nonemotional judgement. This further justifies the fact that mode, an elaborate property of the Western musical pitch system, is used with consistency across studies and subject populations interested in emotional judgements (see Gerardi & Gerken, 1995; Gregory et al., 1996; Kastner & Crowder, 1990).

Altogether, results of the present study (as well as those of our other studies: Peretz et al., 1998a; Peretz & Gagnon, 1999) support the idea that emotional classification of music is performed reliably and effectively by adults with little

musical training. This appears to be quite a strong effect as, in the present study, judgements were determined by the structure of extremely simplified melodies. Again, such a conclusion is rather uncommon in the study of nonmusicians (Smith, 1997). That is, the demonstrated abilities of nonmusicians in the laboratory often fail to match in complexity and efficiency with those presumed to be at work in natural settings. The success we obtained with nonmusicians, although tested in a laboratory with open-ended instructions, is, in all likelihood, related again to the nature of the required task. Asking subjects whether the music evokes some emotional experience, or whether they like or dislike it (as we have done in Peretz, Gaudreau, & Bonnel, 1998b), makes sense to non-musicians because this is one of the primary reasons why they listen to music. Besides, this brings back the question of the possible existence of separate affective and cognitive processing pathways, as is postulated, for example, by Zajonc (1980, 1984). We investigated and discussed this important question in two other studies (Peretz et al., 1998a; Peretz & Gagnon, 1999) through a neuropsychological dissociation.

As far as affective processing is concerned, we can safely conclude that music can be used in studies that demand an effective and reliable emotional medium. Moreover, emotional determinants of music, for instance mode and tempo, are well identified and thus could be manipulated systematically in order to reproduce stimuli that express specific emotions.

In the present study and our previous ones (Peretz et al., 1998a; Peretz & Gagnon, 1999), emotional classifications were, however, reduced to two basic categories, happy and sad, which obviously do not cover the whole range of emotional responses to music. For example, there appears to be another basic category of fearful music (e.g., Krumhansl, 1997). As fear is rarely conveyed by art music and is sometimes confused with anger (e.g., Terwogt & Van Grinsven, 1991), it was not studied. Rather, we opted for a simple and salient dichotomy in these initial explorations, the idea being to establish guidelines for future research with further emotional categories. This strategy enables us to conclude that, as far as the happy-sad categories are concerned, subjects recognise the distinction without hesitation, presumably by drawing on general and shared knowledge about these musical emotions.

Finally, we do not intend to consider that only structural variables, like mode and tempo in the present study, are playing a role in music emotional communication. For such a role, we may easily think of nonstructural variables such as interpretation and instrumentation. However, to our knowledge, the role of the interpreter as opposed to the contribution of the musical structure (i.e., the score) has not been assessed. The same applies to instrumentation. In our previous study (Peretz et al., 1998a) we failed to find any significant influence of both human expression and instrumentation variables. Accordingly, it is our contention that structural content of most (popular) music will predominantly and unambiguously determine emotional responses.

In conclusion, music is often considered to be *the* language of emotion. As it has now been demonstrated that, in music, structural features that are emotionally meaningful are easy to isolate, we suggest that emotional appreciation of music provides a privileged avenue for uncovering the principles of musical knowledge. Accordingly, music can be considered an ideal medium to study cognition as well as emotion.

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REFERENCES

Bharucha, J.J., & Stoekig, K. (1987). Priming of chords: spreading activation or overlapping frequency spectra? *Perception and Psychophysics*, *41*, 519–524.

Brody, L.R., & Hall, J.A. (1993). Gender and emotion. In M. Lewis & J.M. Haviland (Eds.), *Handbook of emotions* (pp. 447–460). New York: Guilford Press.

Cunningham, J.G., & Sterling, R.S. (1988). Developmental change in the understanding of affective meaning in music. *Motivation and Emotion*, *12*, 399–413.

Dalla Bella, S., Peretz, I., Rousseau, L., & Gosselin, N. (2001). A developmental study of the affective value of tempo and mode in music. *Cognition*, *80*, B1–B10.

Dowling, W., & Harwood, P. (1986). *Music cognition*. New York: Academic Press.

Fraisse, P. (1982). Rhythm and tempo. In D. Deutsch (Ed.), *The psychology of music* (pp. 149–180). New York: Academic Press.

Gabrielsson, A., & Juslin, P. (1996). Emotional expression in music performance: Between the performer's intention and the listener's experience. *Psychology of Music*, *24*, 68–91.

Gerardi, G.M., & Gerken, L. (1995). The development of affective response to modality and melodic contour. *Music Perception*, *12*, 279–290.

Gregory, A., Worral, L., & Sarge, A. (1996). The development of emotional responses to music in young children. *Motivation and Emotion*, *20*, 341–349.

Gundlach, R.H. (1935). Factors determining the characterization of musical phrases. *American Journal of Psychology*, *47*, 624–643.

Halpern, A.R., Bartlett, J.C., & Dowling, J. (1998). Perception of mode, rhythm and contour in unfamiliar melodies: Effects of age and experience. *Music Perception*, *15*, 335–355.

Hevner, K. (1935). The affective character of the major and minor modes in music. *American Journal of Psychology*, *47*, 103–118.

Hevner, K. (1937). The affective value of pitch and tempo in music. *American Journal of Psychology*, *49*, 621–630.

Juslin, P.N. (1997). Emotional communication in music performance: A functionalist perspective and some data. *Music Perception*, *14*, 383–418.

Juslin, P.N. (2000). Cue utilization in communication of emotion in music performance: Relating performance to perception. *Journal of Experimental Psychology: Human Perception and Performance*, *26*, 1797–1813.

Kastner, M.P., & Crowder, R.G. (1990). Perception of the major/minor distinction: IV. Emotional connotations in young children. *Music Perception*, *8*, 189–202.

Krumhansl, C.L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology*, *51*, 336–353.

Peretz, I., & Gagnon, L. (1999). Dissociation between recognition and emotional judgement for melodies. *Neurocase, 5*, 21–30.

Peretz, I., Gagnon, L., & Bouchard, B. (1998a). Music and emotion: Perceptual determinants, immediacy, and isolation after brain damage. *Cognition*, *68*, 111–141.

Peretz, I., Gaudreau, D., & Bonnel, A.-M. (1998b). Exposure effects on music preference and recognition. *Memory and Cognition*, *26*, 884–902.

Rigg, M. (1937a). An experiment to determine how accurately college students can interpret the intended meanings of musical compositions. *Journal of Experimental Psychology*, *21*, 223–229.

Rigg, M. (1937b). Musical expression: An investigation of the theories of Erich Sorantin. *Journal of Experimental Psychology*, *21*, 442–455.

Rigg, M. (1939). What features of a musical phrase have emotional suggestiveness? *Bulletin of the Oklahoma Agricultural and Mechanical College*, *36*, 1–38.

Rigg, M. (1940). Speed as a determiner of musical mood. *Journal of Experimental Psychology*, *27*, 566–571.

Rigg, M. (1964). The mood effects of music: A comparison of data from four investigators. *Journal of Psychology*, *58*, 427–438.

Robazza, C., Macaluso, C., & D'urso, V. (1994). Emotional reactions to music by gender, age, and expertise. *Perceptual and Motor Skills*, *79*, 939–944.

Scherer, K.R. (1991). Emotion expression in speech and music. In J. Sundberg, L. Nord, & R. Carlson (Eds.), *Music, language, speech and brain: Proceedings of an international symposium at the Wernner–Gren Center, 5–8 September 1990* (pp. 146–156). Basingstoke, UK: Macmillan.

Scherer, K.R., & Oshinsky, J.S. (1977). Cue utilization in emotion attribution from auditory stimuli. *Motivation and Emotion*, *1*, 331–346.

Sloboda, J.A. (1985). *The musical mind: The cognitive psychology of music*. London: Oxford University Press.

Smith, D.J. (1997). The place of musical novices in music science. *Music Perception*, *14*, 227–262.

Szabadi, E., Bradshaw, C.M., & Besson, J.A.O. (1976). Elongation of pause-time in speech: A simple, objective measure of motor retardation in depression. *British Journal of Psychiatry*, *129*, 592–597.

Terwogt, M.M., & Van Grinsven, F. (1991). Musical expression of moodstates. *Psychology of Music*, *19*, 99–109.

Thompson, W.F., & Robitaille, B. (1992). Can composers express emotions through music? *Empirical Studies of the Arts*, *10*, 79–89.

Watson, K.B. (1942). The nature and measurement of musical meanings. *Psychological Monographs*, *54*, Whole No. 244.

Zajonc, R.B. (1980). Feeling and thinking: preferences need no inferences. *American Psychologist*, *35,* 151–175.

Zajonc, R.B. (1984). On the primacy of affect. *American Psychologist*, *39*, 117–123.