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A developmental study of the affective value of tempo and mode in music

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Abstract

Do children use the same properties as adults in determining whether music sounds happy or sad? We addressed this question with a set of 32 excerpts (16 happy and 16 sad) taken from pre-existing music. The tempo (i.e. the number of beats per minute) and the mode (i.e. the specific subset of pitches used to write a given musical excerpt) of these excerpts were modified independently and jointly in order to measure their effects on happy–sad judgments. Adults and children from 3 to 8 years old were required to judge whether the excerpts were happy or sad. The results show that as adults, 6–8-year-old children are affected by mode and tempo manipulations. In contrast, 5-year-olds' responses are only affected by a change of tempo. The youngest children (3–4-year-olds) failed to distinguish the happy from the sad tone of the music above chance. The results indicate that tempo is mastered earlier than mode to infer the emotional tone conveyed by music.

Keywords: Developmental study; Tempo; Mode

1. Introduction

Music appreciation is a complex skill that is usually considered to be a learned ability. It is presumed to derive from formal musical instruction (e.g. music lessons)

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or, more generally, from long lasting exposure to music. However, several studies over the last two decades have challenged this view by revealing that young children and infants possess many perceptual abilities that are shared with adults (for a review, see Trehub, 1997). For instance, infants as young as 9 months display learning preferences for musical scales (i.e. unequal-step scales) over equal-step scales (Trehub, Schellenberg, & Kamenetsky, 1999) and process consonant intervals better than dissonant intervals (e.g. Schellenberg & Trehub, 1996). Thus, a growing body of evidence suggests that humans are born with predispositions for processing music.

A significant part of music appreciation is mediated by emotional responses. Listeners report these responses as being the primary motivation for listening to music (Pansepp, 1995). Ironically, however, little work has been devoted to emotional responses to music. For instance, when older children show evidence that they can discern happy from sad music (e.g. Cunningham & Sterling, 1988; Dolgin & Adelson, 1990; Terwogt & Van Grinsven, 1991), is this behavior the result of innate predispositions or of a learning process? These questions motivate the present study that focuses on the happy–sad distinction in young children.

Happiness and sadness are basic emotions (for reviews, see Juslin, 1997; Krumhansl, 1997) and are the most reliable and distinguishable musically expressed emotions (e.g. Balkwill & Thompson, 1999; Krumhansl, 1997). Moreover, the major structural determinants of the happy–sad distinction are well identified: tempo (i.e. the number of beats per minute) and mode (i.e. the specific subset of pitches used to write a given musical excerpt). Fast tempi tend to evoke a happy tone, whereas slow tempi tend to evoke a sad tone (Balkwill & Thompson, 1999; Gabrielsson & Juslin, 1996; Gundlach, 1935; Hevner, 1937; Juslin, 1997; Peretz, Gagnon, & Bouchard, 1998; Rigg, 1937, 1940). Similarly, the major mode is associated with happiness and the minor mode is associated with sadness (Hevner, 1935; Rigg, 1937). These relations have recently received empirical support in a study in which both tempo and mode have been independently manipulated in keeping material constant (Peretz et al., 1998).

Although there is compelling evidence that tempo and mode are major determinants of the happy–sad distinction, it is still controversial as to what age children become sensitive to these properties. As far as tempo is concerned, we may hypothesize that infants would display early affective use of it. Indeed, sensitivity to small changes of tempo emerges as early as during the first year of life (Baruch & Drake, 1997; Lewkowicz, 1985; Pickens & Bahrick, 1995). Moreover, tempo, or the rate of events in time, is not limited to music; tempo characterizes many other human behaviors, such as the gate of an individual (or rocking speed). This may explain why tempo is conceived by some scientists (e.g. Drake, 1998) as relying on the operation of an innately determined system. However, sensitivity to tempo has never been assessed through emotional judgments. In contrast, major and minor modes are structural features that are specific to music and hence are likely to be acquired later in life than tempo by exposure to the music of our Western culture. It follows that sensitivity to mode should emerge later than sensitivity to tempo in the developing child. The available data are largely consistent with this prediction. The appropriate

use of mode as a cue for distinguishing happy from sad music is not found prior to 7–8 years of age (Gerardi & Gerken, 1995; Gregory, Worral, & Sarge, 1996; Imberty, 1969; but see Kastner & Crowder, 1990, for an earlier emergence).

The aim of the present study was to assess and compare the relative emergence of sensitivity to mode and tempo via emotional judgments. To this end, the same materials and procedure as adopted by Peretz and collaborators in an earlier study (Peretz et al., 1998) were used here. This method was found to be very effective in assessing the effect of tempo and mode manipulation on the happy–sad distinction. In Peretz et al.'s original study, participants were presented with excerpts drawn from Western music under four conditions resulting from the independent and joint manipulation of tempo and mode. In the 'tempo condition' all tempi were set to the median value of the original tempi of all the excerpts so as to neutralize the effect of tempo on emotional judgments. In the 'mode condition' the excerpts were transcribed in the opposite mode (from major to minor or vice versa). Finally, in the 'tempo + mode condition' both tempo and mode manipulations were applied. A further condition, referred to as 'original', was employed in which excerpts did not undergo any modification. The task was to judge whether each excerpt sounded happy or sad. Results showed that both tempo and mode manipulations affected judgments. In the present study, this paradigm was used with adult participants (Experiment 1) whose performance was compared to that of children aged from 3 to 8 years (Experiment 2).

2. Experiment 1

Since the original study by Peretz et al. (1998) mainly focused on the performance of a neurologically impaired subject (I.R.), experimental conditions were presented in a fixed order and only a few non-impaired participants were considered for comparison. Thus, this first experiment aimed at generalizing the results from Peretz et al. to a larger sample of university students by controlling for potential biases due to the order of presentation.

2.1. Method

2.1.1. Participants

Twenty-four French-speaking students (12 males and 12 females) from the University of Montreal between 19 and 27 years of age (mean 20.4 years) participated in Experiment 1. All were non-musicians (i.e. they did not receive formal musical training, defined as lessons on an instrument or in music theory)[1] and were paid for their participation.

2.1.2. Materials and procedure

The same set of 32 musical excerpts used in the Peretz et al. study was employed

[1] One participant considered herself as a non-musician, although she had taken private lessons and reported being able to read and write music.

here as well (see Peretz et al., 1998, for a thorough description). All excerpts were drawn from Western music and were chosen from the classical repertoire. They were selected so that half evoked a sense of happiness and the other half a sense of sadness. Happy selections were played at a fast tempo and were written in major mode (e.g. 'Brindisi' from Verdi's 'Traviata'); sad selections were played at a slow tempo and were written in minor mode (e.g. Albinoni's 'Adagio'). All excerpts were transcribed for piano and were computer-generated.

In order to assess the respective contribution of tempo and mode to the happy–sad judgments, these properties were systematically manipulated in three different conditions. In the tempo condition, all tempi were set to a unique value[2] (with the quarter note = 84 M.M.) corresponding to the median value of the tempi used for all the excerpts in the original condition (see below). In the mode condition, the excerpts were transcribed in the opposite mode by means of the same procedure described by Hevner (1935). That is, an excerpt in major mode was transformed into minor mode and vice versa. In the tempo + mode condition, the tempo and mode conditions were combined in order to assess the joint influence of tempo and mode manipulations. Finally, the condition in which the excerpts did not undergo any manipulation is referred to as the 'original condition'.

Participants were presented with the full set of 32 excerpts in any of the four conditions and were required to judge whether each excerpt sounded happy or sad. The excerpts were presented in random order in each condition and the order of presentation was different in the four conditions. The response was provided by means of a 10-point scale, with 1 meaning 'sad' and 10 meaning 'happy'. The order of presentation of the four conditions was counterbalanced across subjects. The experiment lasted approximately 1 h.

2.2. Results and discussion

Preliminary analyses did not reveal any effect of sex and order of conditions nor any interaction with the factors of interest (condition and response category). Therefore, these variables were not further examined in the following analyses.

The mean ratings obtained in each condition and provided for the 'happy' and 'sad' excerpts are presented in Table 1. Throughout the present paper, we will consider the excerpts as happy or sad with respect to the a priori classification of the excerpts in their original version (i.e. with 'happy' corresponding to fast tempi and major mode and 'sad' corresponding to slow tempi and minor mode) and not according to participants' judgements. Data were submitted to a 4 (condition) × 2 (response category) repeated measures analysis of variance (ANOVA), considering subjects as the random variable and taking both condition (original, tempo, mode and tempo + mode) and response category (happy and sad) as the within-subjects

[2] Tempi were not simply reversed by presenting, for example, the happy fast excerpts at the slow tempo of the sad excerpts because this procedure produced undesirable effects. The resulting excerpts sounded somewhat unnatural or ill-formed.

Table 1
Mean ratings and standard errors derived from the adults' data in the different conditions defined by the type of manipulation applied to the musical excerpts

Condition	Response category (mean (SE))	
	Happy	Sad
Original	7.7 (0.4)	3.3 (0.3)
Tempo change	6.9 (0.2)	3.5 (0.3)
Mode change	6.7 (0.2)	4.5 (0.2)
Tempo + mode change	5.4 (0.2)	5.0 (0.2)

factors.[3,4] Participants were found to be sensitive to tempo and mode manipulations, as attested by a significant condition × response category interaction ($F(3, 69) = 28.87$, $\varepsilon = 0.42$, $P < 0.001$). In the tempo condition and in the mode condition, the ratings were still significantly higher for the happy than for the sad excerpts ($F(1, 23) = 62.64$, $P < 0.001$ and $F(1, 23) = 34.72$, $P < 0.001$, respectively). This discrimination between happy and sad excerpts vanished in the tempo + mode condition ($F(1, 23) = 1.82$, NS).

Subsequent ANOVAs were performed comparing conditions two by two and considering the same factors as in the overall ANOVA, so as to measure the effect of each manipulation as applied to the original version. Each comparison yielded a robust effect. When compared to the original condition, the tempo condition yielded a significant condition × response category interaction ($F(1, 23) = 12.94$, $P < 0.01$), as did the mode condition ($F(1, 23) = 26.85$, $P < 0.001$) and the tempo + mode condition ($F(1, 23) = 31.23$, $P < 0.001$). Thus, both tempo and mode contributed separately and significantly to the response pattern.

The results demonstrate that tempo and mode are the sole determinants of the happy–sad distinction of the excerpts, since the tempo + mode manipulation cancelled all residual differences between the happy and sad excerpts. Thus, the task is well suited to explore children's affective responses.

3. Experiment 2

3.1. Method

3.1.1. Participants

Sixty-seven French-speaking children participated in Experiment 2. The sample included six 8-year-olds (four males and two females), eight 7-year-olds (four males and four females) and eight 6-year-olds (four males and four females). As these

[3] The Greenhouse–Geisser correction for inhomogeneity of variance was applied whenever appropriate; uncorrected degrees of freedom, epsilon value and probability level following correction are reported.

[4] The same results were obtained when the ANOVA was carried out considering items instead of subjects as the random variable and when the analysis was performed after discarding the only participant with some musical education.

children were the first to be tested and all exhibited similar patterns of responses, they were grouped together in a single 6–8-year-olds category. There were also 15 5-year-olds (eight males and seven females), 19 4-year-olds (five males and 14 females) and 11 3-year-olds (five males and six females). The 6–8-year-olds were all students at an elementary school in the area of Sudbury (Ontario, Canada). The 3–5-year-olds were recruited from nursery schools in Montreal (Quebec, Canada). None of them received formal musical training.

3.1.2. Materials and procedure

The same materials and conditions as those of Experiment 1 were employed. The only difference regarding the procedure was that instead of rating the emotion on a scale, the children responded by pointing to one of two drawings of faces designed to express happiness and sadness (see Fig. 1). This procedure has been shown to be effective in revealing emotional responses in young children (Dolgin & Adelson, 1990; Gerardi & Gerken, 1995; Kastner & Crowder, 1990).

As observed in a pilot study, 3- and 4-year-olds were unable to maintain focused attention for the entire duration of the experiment. Therefore, these children were presented with 16 excerpts per condition (eight happy and eight sad) instead of 32. The full set of 32 excerpts was tested across participants of this age group. In addition, 3- and 4-year-olds were tested in two separate sessions, with two conditions per session.

3.2. Results and discussion

As in Experiment 1, preliminary analyses did not show any effect of sex and order of conditions nor any interaction with the only factor of interest (condition). Hence, these variables were not considered in the following analyses.

The mean percentages of correct responses obtained in each condition and provided by 6–8-year-old and 5-year-old children are presented in Fig. 2. A response was considered as correct when it was the same as the emotion associated with the

Fig. 1. Schematic faces expressing happiness and sadness, used as response alternatives.

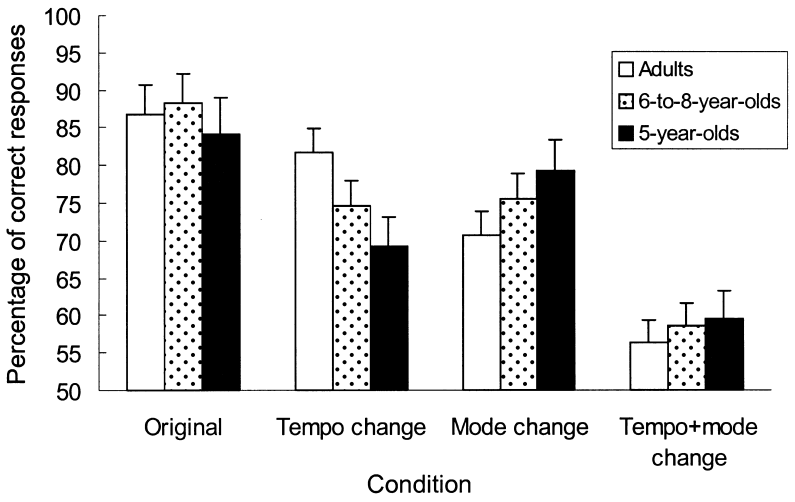

Fig. 2. Mean percentage of correct responses for adults and 6–8-year-old and 5-year-old children in the different conditions defined by the type of modification applied to the musical excerpts in Experiments 1 and 2. Error bars represent standard errors of the mean.

excerpt in its original version. For the sake of comparison, adults' responses from Experiment 1 have been dichotomized by considering scores above and below 5 as 'happy' and 'sad' responses, respectively, and have been included in the following analyses. The results obtained by 3- and 4-year-old children are not reported in Fig. 2 since they performed at chance in all conditions (i.e. the mean percentage of correct responses was $<68.8\%$ by a binomial test). Therefore, 3–4-year-olds were no longer considered in the following analyses. In contrast, the other groups performed above chance in all conditions (by the same criterion), except in the tempo + mode condition.

Data from 6–8-year-olds, 5-year-olds and adults were submitted to a 4 (condition) $\times$ 3 (group) mixed ANOVA, taking subjects as the random variable and considering condition (original, tempo, mode and tempo + mode) as the within-subjects factor and group (adults, 6–8-year-olds and 5-year-olds) as the between-subjects factor. The analysis revealed that the manipulation of mode and tempo had a different impact on the emotional judgements provided by the three age groups, as attested by a significant condition $\times$ group interaction ($F(6, 174) = 3.08$, $\varepsilon = 0.68$, $P < 0.05$).

In order to assess the effect of the structural manipulations for each group, post-hoc pair-wise comparisons were performed by the Tukey HSD test (for unequal sample sizes). To this end, four comparisons have been considered, as shown in Table 2. Comparisons A (original versus tempo) and B (mode versus tempo + mode, by a subtraction logic) are relevant in assessing the specific effect of tempo manipulation on the happy–sad judgement, whereas comparisons C (original versus mode) and D (tempo versus tempo + mode) are critical in assessing the specific effect of mode manipulation. Results showed that adults were highly sensitive to

Table 2
Mean absolute differences obtained by adults and children in each comparison allowing the assessment of tempo and mode[a]

Comparison	Group		
	Adults	6–8-year-olds	5-year-olds
A. Tempo (original versus tempo)	5.0	13.5**	15.0*
B. Tempo (mode versus tempo + mode)	14.3**	17.0**	19.8**
C. Mode (original versus mode)	16.1**	12.6*	4.8
D. Mode (tempo versus tempo + mode)	25.4**	16.2**	9.6

[a] See text for details. Post-hoc pair-wise Tukey HSD test: $*P < 0.05$, $**P < 0.01$.

mode manipulation, whereas tempo manipulation affected their happy–sad judgements to a lesser degree (only comparison B was significant). Similarly, 6–8-year-old children were affected both by tempo and mode manipulations and these manipulations were found to have a comparable effect (all comparisons reached significance). Finally, 5-year-old children are shown to be sensitive to tempo manipulation only.

In all, this second experiment showed that sensitivity to tempo emerges earlier than sensitivity to mode during development, as assessed via emotional judgements. Although there is no metric that allows a comparison of the relative weighting of mode and tempo in judgments, it is unlikely that the absence of an effect of mode change on 5-year-olds' performance is due to low saliency. Changes of mode and tempo were found to contribute equally to the judgments of older children. Furthermore, mode change had even a larger impact than tempo change on adults' judgments.

4. General discussion

The present findings confirm that from 5 years of age, children are able to discriminate between happy and sad excerpts. To do so, 5-year-old children exclusively used information about tempo, whereas 6–8-year-olds, like adults, utilized both tempo and mode. The 3–4-year-old children did not show evidence of mastering such an ability. Altogether the results support the hypothesis that sensitivity to tempo precedes sensitivity to mode, the latter being exploited later than tempo by children to provide emotional judgements. This is consistent with the idea that sensitivity to mode may be more dependent on learning than sensitivity to tempo, thus confirming prior studies showing late emergence of sensitivity to mode (Gerardi & Gerken, 1995; Gregory et al., 1996; Imberty, 1969).

Although 3–4-year-old children were unable to discriminate between happy and sad excerpts, this does not necessarily preclude a sensitivity to this distinction. Indeed, a few methodological choices may have prevented young children from manifesting their knowledge of what is happy and sad in music. First, the music

presented was of the classical genre and included excerpts up to 20th century composers (e.g. Ravel). Such material is adequate for adults, but perhaps less so for young children. Secondly, the task of pointing to schematic faces representing emotional reactions may require meta-analytic skills that are poorly developed at this young age. Future studies should employ music material that is more familiar to this age level, such as music from Walt Disney's movies, and use more indirect behavioral measures, such as dancing responses or facial expressions.

Nonetheless, it is remarkable that by the age of 6, children show full knowledge of the rules that govern the happy–sad character of surrounding music. This ability will remain generally unchanged over a lifetime. The study of emotional judgments of music appears as a powerful means of uncovering the principles of musical knowledge that young listeners bring implicitly to the task. Hence, emotional judgments may provide a new and more promising avenue for probing the development of musical abilities than more traditional non-affective measures, such as same/different discrimination judgments.

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