PREFERRED TEMPI OF IMAGINED COMPOSITIONS

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ABSTRACT

Background. Up to now it is not clear whether the acquisition of a special motor-program by playing a composition is a prerequisite for a precise idea of an adequate tempo in which this composition should be performed.

Aims. The aim of the experimental study was to find out whether musically trained persons have stable tempo preferences of well-known compositions even without having played these compositions and without listening to them while determining the preferred tempo.

Method. Scores of eight well-known compositions for keyboard instruments by J.S. Bach and W.A. Mozart were presented to three different groups of subjects: a) subjects who had played these compositions, b) subjects who had not played them, and c) subjects who were not able to play them. Subjects were asked to imagine these compositions and to adjust an electronic metronome to that tempo of the beat which seemed to be the most appropriate. The display of the metronome was covered. Subjects had to do this task five times on different days. Two measures of dispersion were used: the quotient MM_{max}/MM_{min} and the quotient $MM_{4th\ session}/ MM_{5th\ session}$.

Results. The intrapersonal dispersion of preferred tempi was different for the three groups. Subjects who had played the compositions showed the significantly lowest dispersion and subjects who were not able to play them showed the highest dispersion as represented by the quotient MM_{max}/MM_{min}. Group differences of dispersion became smaller in the course of the experiment showing no significant differences of the quotients $MM_{4th\ session}/ MM_{5th\ session}$ between the three groups of subjects. The interpersonal dispersion of preferred tempi differed showing no unequivocal effect of musical structure.

Conclusions. Playing a composition does not seem to be a prerequisite for stable tempo preferences, at least with well-known compositions. Repeated recall of such compositions from memory seems to induce similarly precise ideas of an adequate tempo. However, the acquisition of special motor-programs contributes to specifying tempo preferences.

1. INTRODUCTION

As early as in 1916, Hugo Riemann stressed the importance of listeners' activity in imagining music. According to Riemann's "Ideen zu einer Lehre von den Tonvorstellungen" (1916), the essence of music is not the actual sound but listeners' imaginations stimulated through the sound. Despite this remarkable early paper, only very few papers have dealt with music in imagery (e.g. Godøy&Jørgensen 2001). This holds true for research on tempo preferences. In the vast majority of these studies, subjects had to reproduce compositions or listen to music excerpts. The results of the studies are nonuniform. Klaus-Ernst Behne (1972), Albert LeBlanc (1988), and Ludwig Grepmair (1990) claim that there is little consensus among listeners in choosing a preferred tempo because tempo preferences are highly determined by individual factors like capability of playing an instrument. Günther Rötter (1997) showed that repeated playing of compositions is more stable with respect to tempo than repeated reading of these compositions. From this study it could be concluded that precise tempo preferences are bound to the execution of a special motor program. However, Daniel Levitin and Perry Cook (1996) who asked subjects to hum well-known popular tunes from memory found that 72% performed such tunes in tempi deviating maximally 8% from the original tempo. In one of my own studies listeners had to adjust the tempo of a computer-controlled performance of compositions of the 18th century to preferred metronomical values. They had to do this task 8 times on different days. Tempo differences between the last two adjustments were only up to 8% for the majority of the compositions. 8% is equivalent to about two degrees on a mechanical metronome. Interpersonal dispersion of the tempi was lowest for compositions with a highly differentiated rhythmic structure and highest for compositions with no differentiated structure, for example with only quavers. So, according to these studies, tempo preferences are precise even without actually playing an instrument or listening to music and they depend not only on subjective factors but also on structural details of the compositions.

To sum it up, the diverse results of research on tempo preferences are still open to discussion.

2. EXPERIMENT

2.1. Aims

The presented study focuses on the following questions:

1. How stable are tempo preferences for compositions that subjects have to imagine or recall from memory, respectively?

2. Are there group differences in intrapersonal dispersion of preferred tempi between subjects who have experience in playing these compositions and those who have no experience but could play the examples and, finally, subjects who are not able to play the compositions?

3. Are there differences in interpersonal dispersion of preferred tempi for compositions having a highly differentiated rhythmical structure and compositions having a low differentiation of rhythmical structure?

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2.2. Subjects

Three groups of subjects participated in the experiment: 10 subjects who were not able to play the piano (group "non-pianists") and 47 subjects who were able to play the piano. This second group had two subgroups: subjects who had already played one ore more of the compositions (group "played"), and subjects who had not (group "not played"). The number of those who had played a composition varied with the examples.

2.3. Stimuli

Scores of the following eight well-known compositions for keyboard instruments were presented to the subjects:

1: J.S. Bach, Prelude in C major, BWV 846 (Well Tempered Clavier, part 1); rhythmical differentiation: 1.0

2: J.S. Bach, Prelude in C minor, BWV 847 (WTC, part 1); rhythmical differentiation: 1.0

3: J.S. Bach, Prelude in E-flat major, BWV 852 (WTC, part 1); rhythmical differentiation: 6.5 (bars 8-9 and 10-15)

4: J.S. Bach, Prelude in A-flat major, BWV 862 (WTC, part 1), rhythmical differentiation: 1.7 (bars 1-5 and 28-32)

5: J.S. Bach, Prelude in D minor, BWV 926; rhythmical differentiation: 2.0 (bars 1-2 and 39-40)

6: J.S. Bach, Prelude in E minor, BWV 941; rhythmical differentiation: 1.0 (left and right hand taken together)

7: W.A. Mozart, Sonata in A major, KV 331, first movement "Andante grazioso" (theme only); rhythmic differentiation: 1.2 (bars 9-12 and 13-16)

8: W.A. Mozart, Sonata in A major, KV 331, "Alla Turca", section 1-6; rhythmical differentiation: 2.1 (section 3 and 4).

These compositions differed with respect to metre (1, 2, 3, 8 in duple metre, 4, 5, 6, 7 in triple metre), mode (1, 3, 4, 7 in major mode, 2, 5, 6, 8 in minor mode) and in their rhythmical structure. In an earlier study (Auhagen 1993) a measure of rhythmic differentiation was developed: the maximum number of melody tones per beat within a theme or motive divided by the minimum number of melody tones per beat in another part of the composition. Accordingly, a quotient of 1 signifies a continuous melodic motion e.g. in quavers, a quotient of 2 means that one part of a composition has twice as many melody tones per beat than another part. This simple measure proved to be a good indicator for the interpersonal dispersion of preferred tempi in the earlier listening experiments. Compositions with a high quotient showed lower dispersion than compositions with low quotients. In the present experiment it was tested whether this holds true for imagined compositions. The degree of rhythmic differentiation of the compositions is shown in the list. Bars which served as a basis of calculation are in brackets.

2.4. Procedure

Subjects were asked to use the scores as an aid for imagining the compositions and to adjust an electronic metronome to that tempo of the beat that seemed to be the most appropriate. During the adjustment task the display of the metronome was covered by a small piece of paper. Subjects had to do this task five times on five different days, the sessions being separated by three days at least. There was no time limit for finding a preferred tempo. On average, one session took 30 minutes. After the last session subjects were asked to fill out a questionnaire. Questions related to the ability to play the piano or other musical instruments, to the familiarity with the stimuli, to the experience with playing one or more of the compositions and to special strategies in finding the "right" tempo.

2.5. Results

2.5.1. Intrapersonal Dispersion of Preferred Tempi

For each subject, two measures of dispersion of the five preferred tempi were calculated: a) the quotient of the highest metronomic value and the lowest metronomic value (MM_{max}/MM_{min}), and b) the quotient of the metronomic values of the fourth and fifth session (MM_4/MM_5 or MM_5/M_4, respectively). An earlier experiment had shown that the interpersonal dispersion of preferred tempi between two successive sessions decreased in the course of the experiment (Auhagen 1993). Therefore, the second measure will test those earlier results.

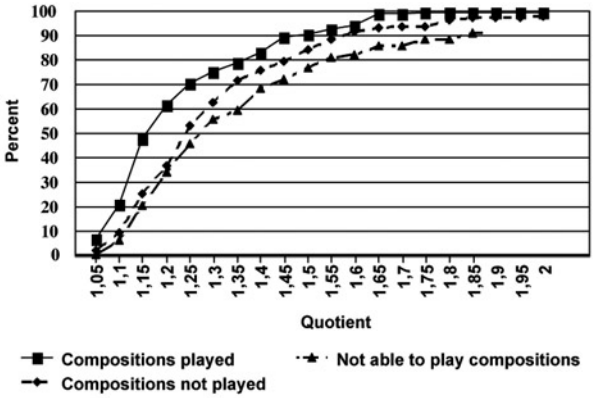

Figure 1: Cumulative distributions of the quotients MM_{max}/MM_{min} of the three groups of subjects across all stimuli ($n_{played} = 109$, $n_{not\ played} = 268$, $n_{not\ able\ to\ play} = 79$).

Figure 1 shows the cumulative distributions of the quotients MM_{max}/MM_{min} of the three subject groups across all music examples. In the group of those who had played the compositions, more subjects showed a low dispersion than in both of the other groups . For example, in the group "played" 48% of the quotients are within a span of 1.15, whereas in the group "not played" only 25% of the quotients are within this span, and in the group "non-pianists" only 20% of the quotients are within the factor 1.15. This factor is equivalent to about 3 to 4 degrees on a mechanical metronome. The Kolmogorov-Smirnov-Test showed significant

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differences between the group "played" and both of the other groups ($p < 0.01$). However, the difference between the groups "not played" and "non-pianists" was not significant.

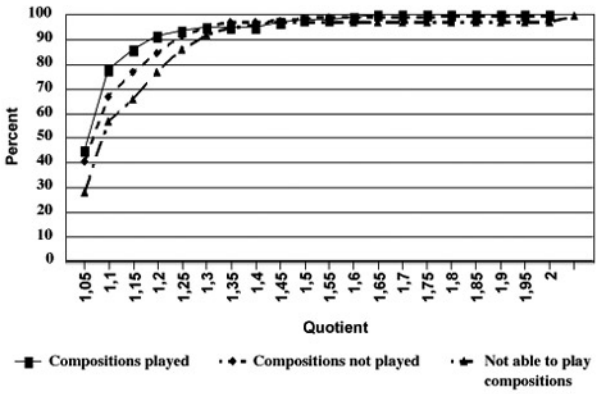

Figure 2: Cumulative distributions of the quotients MM_4/MM_5 of the three groups of subjects across all stimuli.

Figure 2 shows the cumulative distributions of the quotients MM_4/MM_5 of the three subject groups across all compositions. In general, dispersion between the last two sessions is lower than dispersion measured by the quotient MM_{max}/MM_{min}. 86% of those who had played the pieces, 77% of those who had not played the pieces, and 66% of those who were not able to play the pieces show a dispersion of up to 1.15. The Kolmogorov-Smirnov-Test shows no significant differences between the three groups ($p > 0.01$). The difference between the groups "played" and "non-pianists" is significant only on the level of $p < 0.05$. Hence, the acquisition of a special motor program through playing a composition helps to establish a preferred tempo for that special piece. However, repeated recall of a piece from memory seems to lead to a similarly precise imagination of an ideal tempo. The general capability of playing a keyboard instrument does not seem to influence the precision of tempo preferences.

2.5.2. Interpersonal Dispersion of Preferred Tempi

Distributions of subjects' mean preferred tempi (geometric mean of the five metronomic values) were calculated for every music example. Variance and mean of these distributions were calculated after logarithmic transformation of the metronomic values. Table 1 shows the compositions arranged according to the variance of the distributions of the logarithmic metronome values. In earlier experiments, compositions with low or no rhythmic differentiation had shown high interpersonal dispersion, and compositions with high rhythmic differentiation low dispersion. The results of the present study are only partly conform to these earlier results: the prelude in A-flat major and in D minor both having high rhythmic differentiation show low dispersion whereas the first movement of Mozart's sonata and the preludes in C major and C minor both having low rhythmic differentiation show high interpersonal dispersion. However, the prelude in E-flat major has high rhythmic differentiation in combination with high dispersion. Obviously, there is a difference between listening to music and recall of music from memory. Probably it is difficult to imagine a rhythmically very complex composition correctly in the exact temporal structure whereas it is probably easy to imagine a composition with only a few different note values.

Prelude in E minor	**0.003088**
Prelude in A-flat major	**0.003576**
Prelude in D minor	**0.005202**
Rondo "Alla turca"	**0.005869**
Prelude in C major	**0.006310**
Prelude in C minor	**0.006500**
Prelude in E-flat major	**0.007839**
Sonata in A major, 1st movement	**0.015967**

Table 1: Order of compositions according to variance of the distributions of the logarithmic metronome values across all subjects

An F-test was performed across the distributions of mean preferred tempi for all music examples. The theme of the first movement of Mozart's piano sonata in A major shows significantly higher variance of mean metronomic values than any other music example ($p < 0.01$). On the other hand, Bach's prelude in E minor shows significantly lower variance than the preludes in E-flat major, C minor and C major, and the first movement of Mozart's sonata in A major ($p < 0.01$). This result was not expected, since both music examples belong to the category of compositions in triple metre with low rhythmic differentiation. Probably the 6/8-metre of the sonata in A major caused some problems. While some subjects chose the quaver as beat value others chose the dotted crotchet. This may have led to different tempi. Another explanation is that although the score presented to the subjects had no tempo indications, this well-known piece is an "Andante". This type of movement is especially problematic because research in historical performance practice has shown that in the 18th century it was not played as slowly as it was assumed for a long time (Miehling 1993). Therefore, subjects who had some knowledge in this field of research may have chosen other tempi than subjects who were "unhampered" by such information.

The low interpersonal dispersion of values of the prelude in E-minor can not be explained easily. The measure of rhythmic differentiation was calculated assuming that the parts of the left and the right hand should be taken together. On condition that listeners perceive the rhythmic structure as a combination of both parts, a continuous motion in quavers results. If one considers only the right hand, the rhythmic differentiation is higher because measures with quavers and measures with crotches alternate.

2.5.3. Mean Preferred Tempi

Medians of the distributions across the three subject groups were calculated and compared with tempi chosen by well-known pianists (table 2). For the majority of examples, subjects' medians (representing a kind of average preferred tempo) are very close to at least one professional performance.

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J.S. Bach, Preludes from the Well Tempered Clavier

	C maj.	C min.	E-flat maj.	A-flat maj.
Gieseking (1950)	**108**	**140**	**95/72***	**108**
Gould (1975)	**60**	**80**	**34/68***	**95**
Jarrett (1988)	**80**	**90**	**68**	**112**
Schiff (1984)	**80**	**90**	**74**	**108**
Subjects	**79**	**95**	**77**	**97**

W.A. Mozart, Sonata in A major

	Andante	"Alla Turca"
Ousset (1973)	**141**	**141**
Schiff (1981)	**150**	**136**
Subjects	**139**	**104**

Table 2: Tempi of records and average tempi (median) of subjects (* means two different tempi in bars 1-9 and 10-70).

3. GENERAL DISCUSSION

The results of the presented study help to understand the role of the acquisition of a motor program in imagining a preferred tempo. Taken the quotient of the highest and the lowest values of five adjustments of a metronome to the preferred tempi of imagined compositions as a measure of dispersion, subjects who had played these compositions showed significantly lower dispersion than subjects who had not played the compositions and subjects who could not play them. The dispersion of the tempi of the last two groups did not differ significantly. This means that not the general ability of playing an instrument seems to contribute to precise recall of preferred tempi, but rather a concrete motor program developed for playing a special composition. Taken the quotient of the last two metronome adjustments as a measure of dispersion the picture changes: with all groups of subjects this measure is lower than the quotient MM_{max}/MM_{min}. In addition, the differences between the three groups become smaller and no difference is statistically significant, given an error of 1%. Given an error of 5%, the difference between subjects who had played the compositions and subjects who could not play them is significant. This indicates that in the course of the experiment even subjects who had not acquired a general motor program of piano playing got a more precise recall of preferred tempi by repeatedly imagining the test-stimuli. Obviously, all subjects built up a mental representation that included a relatively small range of preferred tempi.

Concerning the interpersonal dispersion of preferred tempi, the hypothesis that compositions with a highly differentiated rhythmic structure show low dispersion whereas compositions with a low differentiation show high dispersion was only partly supported by the data. The low dispersion of preferred tempi for the Prelude in E minor and the high dispersion of preferred tempi for the Prelude in E-flat major contradict this hypothesis. In the case of the Prelude in E-flat major the composition was probably too complex for a small range of preferred tempi. This idea is supported by the analysis of several performances of this composition: while Keith Jarrett and András Schiff played different parts of the composition in one tempo (with only small deviations) Walter Gieseking and Glenn Gould chose different tempi for different parts. Since subjects could choose only one tempo, they probably had different opinions which part of the composition should be taken as point of reference. As to the Prelude in E minor, calculation of the index of rhythmical differentiation was based on the combined rhythmic pattern of all parts forming a chain of quavers. However, the internal differentiation of the upper voice is not low because bars with only quavers and bars with only crotchets alternate. Probably, subjects did not perceive this composition as having no rhythmical complexity.

Concerning the average preferred tempi (the medians of the distributions across all subject groups), these tempi are within a range of tempi played by pianists with a tendency to moderate tempi. So even without performing a composition or even without being able to perform a composition, subjects chose preferred tempi that were conform to existing recordings. A preliminary analysis of the questionnaire indicates that most of the subjects did not try to remember the tempi of special performances while searching for a preferred tempo. Therefore, the problem which factors lead to concrete preferred tempi still has to be solved.

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