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DIURNAL VARIATION IN PERFORMANCE BY ORCHESTRAL VIOLINISTS – PILOT STUDY

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Abstract : Human physiological parameters and performance depend on circadian rhythm. However, no information exists about diurnal variation of musicians' performance characteristics. In a pilot study 6 professional violinists (aged 38–57 years) presented a standard piece of music (Johann Sebastian Bach, Partita Nr. 2 a-moll, BWV 1004, 4. Satz „Gigure") and were assessed for body temperature, vital signs and musical performance criteria at 8.00 H, 12.00 H, 16.00 H and 20.00 H. There was no uniform variation but artistic presentation appear to have an optimum between 12.00 and 16.00 H, sound instability being most pronounced in the morning hours.

Key words : diurnal variation, musician, performance characteristics, violinist

INTRODUCTION

Circadian rhythm influences physiological functions and performance of humans substantially 1, 2, 3. There is no unequivocal peak of physical performance, but coordination, reaction time or vigilance appear to have acrophases around 16.00 H. Heretofore, diurnal variation of musicians' performance has not been subject of research and almost no specific data of controlled studies are available with regard to musicians´s performance and presentation. Mulcahy and colleagues (4) monitored circadian heart rate in members of a symphony orchestra and found a substantial influence of environmental factors such as live presentations on the rhythm. In analogy, Monk et al. (5) studied diurnal variation of human performance and found maxima of dexterity during evening hours between 17.00 H and 21 H. Cognition (reasoning speed) revealed a maximum in the late afternoon hours. In general, performance characteristics were closely related to body temperature showing minima at low body temperatures (6). In order to assess circadian rhythms of musicians, the objective of this investigation was to first get data on diurnal variation of performance characteristics in professional violinists and stimulate further research in the field.

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METHOD

Six orchestral violinists (3 male and 3 female, aged 38 to 57 years, median 50; median BW 50 kg, range 19; median height 165.5 cm, range 17) arrived at the study centre at 07.30 H and gave their written informed consent. The study was approved by the ethics committee of the University of Dresden. Standard meals (breakfast, lunch, dinner) were served. At 08.00 H, 12.00 H, 16.00 and 20.00 H temperature (BT), vital signs (BP, HR) were controlled as marker rhythms (BT: Braun Thermoscan ear thermometer; BP/HR: Boso Medicus Family sphygmomanometer). Each volunteer presented the same standard piece of music (Johann Sebastian Bach, Partita Nr. 2 a-moll, BWV 1004, 4. Satz „Gigure") following recording of vital signs. In order to minimize learn effects all participants started to train the presentation 4 weeks before the study.

The tempo (bpm) of the presentation was objectively measured using a metronome (Cubase Studio 4). Agogic, tempo fluctuations, clarity of sounds, dynamics, articulation, expression, technical problems (score: 10-no of problems) and overall artistic presentation were scored by a blinded rater (between 9.00 and 11.00 a. m.) using a visual analogue scale (0 = bad to 10 = excellent) (7). All data were analysed descriptively (mean, SEM) and explorative Friedman ANOVA (Friedman test FT) was calculated (8). In order to estimate relation between body temperature and music characteristics Pearson correlation and cross-correlation techniques were applied (9). All calculations were done using commercially available software (NCSS 2000, NCSS, Kaysville, Utah, USA).

RESULTS

Vital signs (blood pressure, heart rate) showed a marked individual variability with mean maximum values at 08.00 H and 16.00 H. An expected acrophase of body temperature (BT) in the evening hours (16.00 H and 20.00 H) could be ascertained ($P<0.05$). The circadian characteristics of music presentation characteristics and BT are summarized descriptively in Table I. The maximum values of musical performance with regard to artistic presentation (tempo, articulation, dynamics, expression and overall performance)

TABLE I: Diurnal variation of mean values (±SEM) of musical characteristics and Body Temperature (*) $p<0.05$).

Characteristic	*08.00 H*	*12.00 H*	*16.00 H*	*20.00 H*
Tempo [bpm]	111.3 (2.11)	115.8 (2.11)	110.3 (2.11)	114.3 (2.11)
Fluctuation of tempo [sc]	6.3 (0.74)	5.2 (0.74)	5.4 (0.74)	5.3 (0.74)
Clarity of sounds [sc]	5.3 (0.73)	5.1 (0.73)	4.9 (0.73)	4.5 (0.73)
Articulation [sc]	3.3 (0.34)	3.4 (0.34)	3.8 (0.34)	3.1 (0.34)
Dynamics [sc]	4.6 (0.57)	4.8 (0.57)	4.8 (0.57)	3.7 (0.57)
Expression [sc]	4,2 (0.72)	4.5 (0.72)	4.8 (0.72)	3.8 (0.72)
Agogic [sc]	4.2 (0.66)	4.1 (0.66)	4.1 (0.66)	3.1 (0.66)
Technical problems [sc]	7.3 (0.65)	7.5 (0.65)	7.8 (0.65)	7.7 (0.65)
Overall Presentation [sc]	4.3 (0.66)	4.4 (0.66)	4.7 (0.66)	3.8 (0.66)
Body temperature (°C)*)	36.5 (0.12)	36.3 (0.12)	36.7 (0.12)	36.7 (0.12)

showed a maximum at 12.00 H or 16.00 H. However, criteria referring to the stability of the sounds (clarity of sound or fluctuation of tempo [p=0.07, FT] and agogic) were slightly pronounced in the morning at 08.00 H. The error bar plot of diurnal variation of the variable "fluctuation of tempo" with a maxium in the morning is depicted in Figure 1. Technical problems were more frequently observed in the morning.

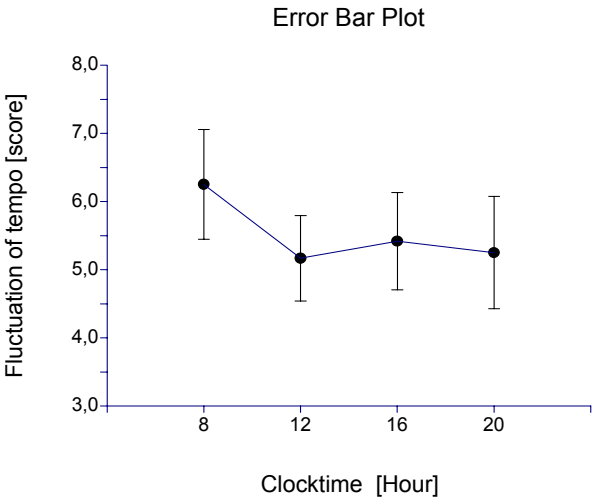

Fig. 1 : Diurnal variation of the parameter "Fluctuation of the tempo" [mean, SEM] which tends to result in a maximum in the morning hours (p=0.07).

Correlation analysis showed associations of presentation characteristics with body temperature, Pearson correlation coefficient – corresponding to a time lag of zero - being most marked for the variable sound clarity (r=0.36, p=0.08), which is given in Figure 2. Agogic, expression and overall presentation were correlated by trend with body temperature between 0.2 and 0.3. Cross-correlation technique revealed the highest correlation coefficient for the parameter expression at a time lag of –1 with 0.49 (P<0.05) with regard to body temperature

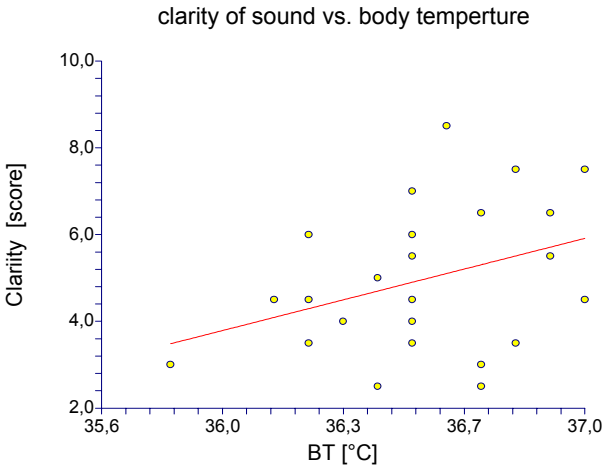

Fig. 2 : Scattergram of "Clarity of sound" versus BT with a positive trend (p=0.08, r=0.36).

(P<0.05) with the corresponding correlogram in Figure 3. All music presentation characteristics apart from technical problems and fluctuation of tempo – no clear cross-correlation - were positively correlated (between 0.3 and 0.45) at time lags between –1 and +1, i. e. with a slight temporal shift.

Conclusion

These preliminary results speak in favour of a differentiated approach of musician's presentation with less stability of sounds in the morning and overall trend to better artistic presentation in the afternoon. Previous studies postulated a correlation between body temperature on the one hand and alertness or performance on the other hand (10). As a result of this pilot study body temperature is also associated with music presentation, i. e. these characteristics appear to be coupled with body temperature. These preliminary results cannot be generalized but are in keeping with the

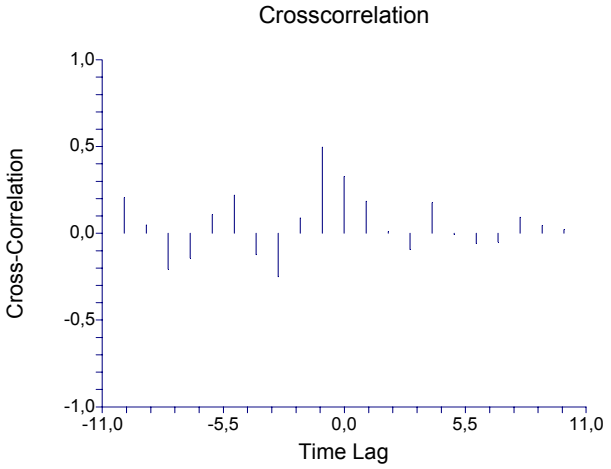

Fig. 3 : Cross-correlation diagram of the parameter "expression" versus BT. Maximum value is found at a time lag of –1 with 0.49.

physical exercise study of Monk et al. (5) that afternoon may be a favourable time span for musical presentation. Due to the pilot conditions of the investigation only a low number of musicians and co-workers were available for the present project. Therefore, further studies with orchestral musicians are necessary to substantiate the results and conclusions.

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