

# Biographical predictors of music-related motor skills in children pianists

**Hans-Christian Jabusch<sup>1</sup>, Raymond Yong<sup>2</sup>, and Eckart Altenmüller<sup>1</sup>**

<sup>1</sup> Institute of Music Physiology and Musicians' Medicine,  
Hanover University of Music and Drama, Germany

<sup>2</sup> Faculty of Music, University of Melbourne, Australia

This study aimed to identify biographical predictors of children pianists' motor skills in a relevant musical context. Motor skills at the piano were assessed in 30 piano-playing children by testing temporal evenness in standardized scale playing which is a basic element of piano technique. Questionnaires were used to collect detailed information regarding the practice habits and other biographical factors. Associations between performance values and variables from the questionnaire were investigated by multiple regression analysis. Besides the duration of piano education and the frequency of technical exercise, motivational factors and parental supervision predicted children pianists' motor skills in the selected motor task, i.e. in a relevant musical context.

*Keywords:* sensorimotor learning; motor skills; practice; music performance; piano

Performing instrumental music is one of the most complex of human accomplishments. Musicians' motor coordination is highly complex and takes place at an extremely high level of spatiotemporal accuracy. Successful strategies for the acquisition of motor coordination and musical abilities required for this challenging task are of interest to both instrumental teachers and expertise researchers.

A number of publications have reported on research that related biographical variables with musical performance achievement (for a review, see McPherson 2006). So far, little attention has been paid to the acquisition of motor skills in children musicians and, in particular, of motor performance in relevant musical tasks. Objective quantification of motor performance in a relevant musical task was previously carried out in professional pianists while they were playing standardized C major scales (Jabusch 2006). Scale playing

is one fundamental aspect of piano technique. In C major scales played by professional pianists, a high degree of temporal evenness in the inter-onset intervals was revealed using a Musical Instrument Digital Interface (MIDI)-based analysis method. This method has been shown to be a valid and reliable tool to investigate temporal evenness in scale playing of pianists (Jabusch *et al.* 2004).

In the present study, we examined children pianists' motor performance as measured by temporal evenness in scale playing, and investigated biographical factors and their association with motor performance. These biographical factors included the child's history of practicing and learning the piano, information regarding their everyday musical environment, their attitudes towards music and practice, their subject preferences at school, and the extent to which their parents supervised their practice.

## METHOD

### Participants

The subjects for the study comprised 30 school-aged children who were taking piano lessons at the time of the study (22 girls and 8 boys, aged between 8 and 17 years old, median age 13). Of the participants, 26 took their piano lessons at the Hanover music school, while four subjects were taking lessons at the Hanover University of Music and Drama. All subjects had been learning the piano for at least nine months prior to the study. The only inclusion criterion was the ability to play C major scales with both hands. Informed consent was obtained by all participants and their parents.

### Materials

A questionnaire was developed that sought information on the general pianistic and musical history of the subject, focusing on details of their practice amount and content (e.g. retrospective assessment of practice quantity, repertoire, frequency of practicing technical exercises), details of piano lessons (e.g. content of lessons, number of piano teachers in the past), their attitudes towards music and practice, and their involvement in other musical activities. Subjects were asked about musical activities in the family and how often a parent supervised them during their practice at home. A series of questions asked the children to rate their enjoyment of five different school subjects (music, mathematics, visual arts, sport, and language). Subjective ratings (e.g. of frequencies or of enjoyment) were encoded on corresponding 5-point scales. The questionnaire was completed with the

assistance of a single researcher who was available to give clarifications when uncertainties arose in the questions. Parents of the younger subjects were asked to assist in the answering of questions.

### **Procedure**

The procedure of scale playing and analysis of temporal evenness was performed according to a protocol published previously (Jabusch *et al.* 2004). Scales were performed on a digital piano that was connected to a computer. For the test, sequences of 10 to 15 C major scales were played over two octaves (range: C3-C5) in both directions, inward and outward, with each hand separately. Participants were asked to play in legato-style. Fingering was according to the regular C major fingering. The tempo was standardized and paced by a metronome (80 beats per minute, two notes per beat). Inter-onset intervals for all individual notes of the scales were analyzed using a researcher-developed software. Scale analysis was performed for each hand and in both directions separately. Mean standard deviations of inter-onset intervals (msdIOI) were calculated for all scales of each hand and playing direction. The msdIOI parameter was previously shown to be a reliable indicator of temporal evenness in pianists' scale playing (Jabusch *et al.* 2004). The median of the msdIOI values of both hands and playing directions (MIOI) indicated the overall temporal unevenness of note onsets for each participant.

Pearson correlations were calculated to detect associations between performance values and variables from the questionnaire. Stepwise multiple regression analyses were used to assess predictability of performance results. The two-tailed level of statistical significance was set at  $p < 0.05$ .

### **RESULTS**

Participants began to play piano between the age of 5 and 12 years (median=7 years) and the duration of their piano education was between 9 months and 12 years (median=5 years). The median daily practice time was 0.5 hours (range=0.2-3.5), and the median total life practice time was 559 hours (range=88-8700).

Results from the questionnaire regarding participants' attitudes towards music, performing, practice, and technical exercises, as well as the frequency of parental supervision and technical practice are displayed in Figure 1.

In the performance test, all children were able to play the scales according to the protocol. MIOI indicated the overall temporal unevenness of note onsets for each participant. A *low* score for MIOI denotes a *low* level of un-

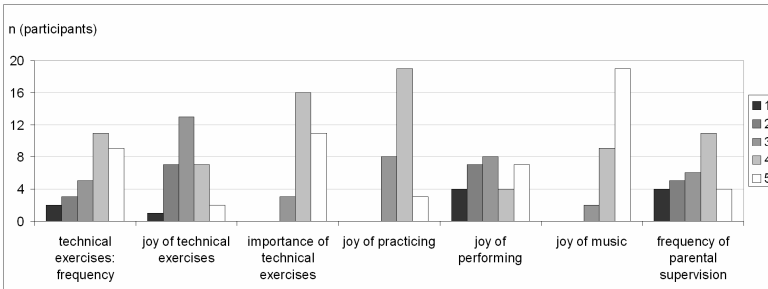


Figure 1. Distributions of results from the questionnaire. Frequencies are coded as 1=never, 2=rarely, 3=sometimes, 4=often, and 5=very often. In the displayed enjoyment rating scales, 1 represented a negative enjoyment rating and 5 a positive enjoyment rating. In the rating of importance, 1 represented a low importance and 5 a high importance.

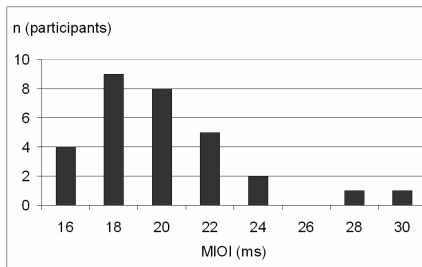


Figure 2. Distribution of motor performance results. MIOI values indicate the individual overall temporal unevenness of note onsets in standardized scale playing for each participant.

evenness in the scales (high temporal onset precision), while a *high* score for MIOI denotes a *high* level of unevenness (low temporal onset precision). Distribution of performance results is given in Figure 2.

A correlation was observed between the motor performance values MIOI and the daily practice time ( $r=-0.45, p<0.05$ ), the total life practice time ( $r=-0.46, p<0.05$ ) and the duration of piano education ( $r=-0.41, p<0.05$ ). Stepwise multiple regression analysis revealed a model predicting 68% of the variance of MIOI values, with the following six items of the questionnaire as predictors: duration of piano education (30%), enjoyment of practice (10%), frequency of practicing technical exercises (9%), enjoyment of the subject

Table 1. Information on the model revealed by stepwise multiple regression analysis.

Regression equation	$R^2$	$R^2$ adjusted
MIOI = 44 - 0.97 (years piano) - 1.6 (joy practice) - 1.2 (frequency exercises) + 2.9 (joy art <sub>rel</sub> ) - 0.93 (parental supervision) - 1.6 (joy music)	0.76	0.68

*Key.* MIOI=individual overall temporal unevenness of note onsets (ms); years piano: duration of piano education (years); joy practice= enjoyment rating of practice (high value represented a positive enjoyment rating); frequency exercises=frequency of practicing technical exercises (high value represented a high frequency); joy art<sub>rel</sub>=enjoyment rating of visual arts at school, relative to enjoyment ratings of other subjects (low value represented a high enjoyment); parental supervision=frequency of parental supervision (high value represented a high frequency); joy music=enjoyment rating of music (high value represented a positive enjoyment rating).

visual arts at school (7%), frequency of parentally supervised practice (6 %), and enjoyment of music (6%). Details are given in Table 1.

## DISCUSSION

The aim of the study was to identify biographical predictors of children pianists' motor skills in a relevant musical context. According to expectations, variables that determined the amount of time children spent at the instrument (daily practice time, total life practice time, and total years playing the piano) were significantly correlated with temporal fine motor precision. Moreover, the duration of piano education was a predictor for temporal fine motor precision. These findings coincide with the principle suggested by Ericsson *et al.* (1993) proposing 10 years and 10 000 hours of deliberate practice required for the acquisition of expertise. Our results are in keeping with results of various studies that related the number of years of practice with instrumental achievement (e.g. Sloboda and Davidson 1996, McPherson 2005). The frequency of technical practice, a predictor of fine motor precision explaining 8% of the variance in the temporal onset precision, can be classified as one type of deliberate practice according to the definitions described by Ericsson *et al.* (1993). External and internal motivational factors were frequently described as influential factors for musical development. Sloboda and Davidson (1996) emphasized the possibility and necessity of external motivation developing into internal self-motivation by the early teenage years as a prerequisite to sustain the commitment required to persist with musical instrument learning. In the

present study, the frequency of parentally supervised practicing represents an external motivational factor that turned out to be a predictor of temporal fine motor precision. The predictors enjoyment of practice, enjoyment of music, and enthusiasm for the subject visual arts at school may represent internal motivational factors not only for making music but additionally for a further artistic disposition. Taken together, predictors of motor skills in children pianists cohered with factors previously found to influence musical achievement at the instrument, even with the focus on a selected motor task in a relevant musical context.

### **Acknowledgments**

The authors would like to express their appreciation to all participating piano students and to the piano faculty of the Musikschule Hannover for their kind support.

### **Address for correspondence**

Eckart Altenmüller, Institute of Music Physiology and Musician's Medicine, Hanover University of Music and Drama, Hohenzollernstr. 47, 30162 Hanover, Germany;  
*Email:*altenmueller@hmt-hmt-hannover.de

### **References**

- Ericsson K. A., Krampe R. T., and Tesch-Römer C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100, pp. 363-406.
- Jabusch H. C., Vauth H., and Altenmüller E. (2004). Quantification of focal dystonia in pianists using scale analysis. *Movement Disorders*, 19, pp. 171-180.
- Jabusch H. C. (2006). Movement analysis in pianists. In E. Altenmüller, J. Kesselring, and M. Wiesendanger (eds.), *Music, Motor Control and the Brain* (pp. 91-108). Oxford: Oxford University Press.
- McPherson G. E. (2005). From child to musician: Skill development during the beginning stages of learning an instrument. *Psychology of Music*, 33, pp. 3-35
- McPherson G. E. (ed.) (2006). *The Child as Musician: A Handbook of Musical Development*. Oxford: Oxford University Press.
- Sloboda J. A. and Davidson J. W. (1996). The young performing musician. In I. Deliège, and J. A. Sloboda (eds.), *Musical Beginnings: The Origins and Development of Musical Competence*. (pp. 171-190). Oxford: Oxford University Press.