RESEARCH ARTICLE

ACTA Vol. 13, No. 3, 2015, 237-252
NEUROPSYCHOLOGICA

Received: 18.02.2015
Accepted: 23.09.2015

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

DOI:10.5604/17307503.1172474

CORRELATION BETWEEN THE METACOGNITIVE SELF AND SELECTED FORMS OF MUSICAL TRAINING

Rafał Lawendowski[1(A,B,C,D,E,F)], Michal Kierzkowski[2(A,B,E,F)], Karol Karasiewicz[1(C,D,F)]

[1] Institute of Psychology, University of Gdańsk, Poland
[2] The Stanislaw Moniuszko Academy of Music, the Faculty of Choral Conducting, Church Music, Arts Education, Eurhythmics and Jazz, Poland

SUMMARY

Background: The paper presents the concept of the metacognitive self and its correlations with selected features of musical training. Accurate insight into deviations from the rationality in one's behaviour might be related to deliberate planning, analysing, and evaluating performance, as well as explaining the factors contributing to the results of musical training. It has been also assumed that the level of the metacognitive self could depend on the specific features of training, such as intensity and duration.

Material/ Methods: Research tools included a questionnaire constructed for the aim of the study, which measured variables associated with musical behaviour and the MJ-40 Scale, assessing the accuracy in the recognition of one's own irrationality. The MJ-40 Scale comprises five subscales: judgemental biases, memory biases, irrationality in thinking, recognition of social influence and recognition of conflict between morality and efficiency. The technique of computer-assisted personal interviewing (CAPI) was adopted in the research.

Results: The results show a significant correlation in the duration of musical training and accuracy in the perception of one's own behaviour. The number of years devoted to musical training and the proportion of time spent on improvising during everyday practice, facilitate more frequent reflection on cognitive processes and thereby enhance accuracy in the recognition of one's own irrationality.

Conclusions: The presented study might provide insight into self-perception processes, specifically self-knowledge determined by the psychological processes entailed in musical training. As the previous descriptions and explanations of the relations between musical behaviour and the metacognitive self are incomplete, further research is necessary.

Key words: metaknowledge, metacognition, cognitive functions, musical training

INTRODUCTION

Works of music of different genres, musical forms, and various interpretations, despite their diversity, share one common feature – they develop specific skills in their performers or composers. Firstly, musical behaviour involves different forms of complex motor behaviours. Playing an instrument requires highly specific technical and performance skills (Costa-Giomi, 2005; Hallam, 1995; Hallam, 2001), such as an appropriate posture, the position of hands and fingers, the speed of hand shifting, the precision of key attack, the ability to play without watching one's hands, and the ability to follow notation. Secondly, they develop musical competences, executed in an intellectual functioning, e.g. aural and performance skills or manipulation of musical symbols (Gardner, 1973; Gordon, 1997; Schellenberg, 2006). Moreover, musical training develops various capacities which might enhance non-musical achievement based on mental processes (Degé et al., 2014). Research has indicated a positive correlation between the regular attendance of music classes and a number of competences, such as reading (Anvari et al., 2002), mathematical (Vaughn, 2000), and spatial-temporal skills (Rausher & Hinton, 2006). Cross-sectional and longitudinal studies have shown that music learners score higher on tasks involving verbal (Chan et al., 1998) and visual memory (Jackobson et al., 2008), and as a result, perform better at school (Wetter et al., 2009). It has been proved that music class participation and the accompanying effects might result from a higher general intelligence (Schellenberg, 2004). Thus, musical training enhances various features of intellectual functioning both in convergence with general intelligence and, this should be emphasised, independently of it (Tierney et al., 2009). However, most of the cited studies are correlational, and the causality of the observed effects has not been determined yet.

To sum up, musical training may be related to the quality and effectiveness of the cognitive processes involved in data processing (Czerniawska, 2012). What is more, it might develop capacities associated with self-insight and self-interpretation, e.g. in the domain of self-knowledge (Degé et al., 2014). Elaboration of a musical piece and practising playing an instrument are multi-faceted skills (Hallam, 1997). They involve the awareness of aims, their deliberate prioritising, and the employment of the optimal strategies for their attainment, requiring e.g. self-control. Further, communication between a sender (e.g. a composer or a teacher) and a receiver (e.g. a student or a musician) is primarily based on conscious processes (Pachalska et al., 2014). Not surprisingly, numerous biographies of famous musicians demonstrate how music has taught them a different kind of thinking about themselves. Their experience also shows that learning music develops other capacities, such as cooperation, listening, imagination, association of distant ideas, and the simultaneous focus on the present and future (Wilsz, 2012). A common feature of the above is the enhanced self-consciousness and self-reflection of these individuals. While this explains why practising music might influence the cognitive functions of musicians (Hallam & Barry,

2002), it has not been determined yet how accurate musicians' insight into themselves is.

What must be noted, is that music is not the sole factor determining the shape and the outcomes of broadly defined cognitive processes (Czerniawska, 2012). Other, deeper dimensions of individual differences, such as perceptual strategies (cf. Lawendowski et al., 2014), temperament (Kantor-Martynuska, 2009), personality traits (Rentfrow & Gosling, 2003), and preferences associated with them (Lawendowski, 2011), might influence the characteristics of the beliefs pertaining to self. Interestingly, these preferences and a musical education are particularly important for brain activation (Caldwell & Riby, 2007; Seung et al., 2005). For this reason, and because of the significance of the biological correlates of self-esteem, to analyse the influence of musical training on cognitive functions enhancement, we shall discuss yet one more issue: the role of musical experience in music processing by the brain.

Neuropsychological correlates of musical training

Various strategies of solving musical problems trigger functional and structural changes in brain. The individual history of learning is reflected in neural processing (Altenmüller, 2003). In response to learning and external stimuli, the cortex self-organises (Pantev et al., 2003). Numerous studies report changes, such as the increased response of particular neurons or the increase in the number of neurons responding to sounds which are particularly significant to the student (Pantev et al., 1998; Weinberger & Bakin, 1998). A tone which is for some reason important to the student (e.g. 440 Hz) causes enlargement of the region activated by the relevant frequency (Pantev et al., 1998). Pantev's research has proved that intense training leads to increased brain activity in relevant brain structures, e.g. the brains of professional trumpet players respond more strongly to the sound of the trumpet, but not the violin (Pantev et al., 2001). Interestingly, corresponding evidence shows that not only does music, but also speech elicits a stronger response in the brain stems of musicians (Musacchia et al., 2007), and that their auditory cortex is larger than in controls (Schneider et al., 2002). The size of this difference depends on the duration of musical training. The correlation of long-term musical training and the distinct pattern of brain activation in individuals with musical experience has been further proved by Seung et al. (2005). In their study, participants without formal musical training responded to a pitch comparison task with activation in the right frontal lobe and the right superior temporal gyrus (Altenmüller, 1989). In contrast, professional musicians responded to the task with increased left hemisphere activation (Ohnishi et al., 2001).

Thus, learning and memorising musical pieces facilitate structural plasticity, reflected in permanent morphological changes to the microstructures of brain (Münte et al., 2002; cf. Pąchalska et al., 2014). Changes observed in musicians include enlargement of the regions responsible for the control of the movements of fingers used for playing a given instrument. Elbert et al. (1995) have proved

that violinists have significantly larger brain regions receiving tactile stimuli from four fingers of the left hand, which perform quick and complex movements. Further, it has been reported that musicians have a larger frontal region of the corpus callosum (a structure situated between the left and the right hemisphere, facilitating communication between the hemispheres and as such facilitating coordination of the movements performed by the left and the right hand) than controls (Schlaug et al., 1995a). Other studies have indicated that professional musicians have on average a 5% larger cerebellum (Wieser, 2003) and a greater volume of gray matter located within the right posterior and middle cingulate gyrus, left superior temporal gyrus and right inferior orbitofrontal gyrus (Fauvel et al., 2014).

The discussed changes might be further illustrated by the fact that professional musicians who have developed absolute pitch have larger left planum temporale (Schlaug et al., 1995b). It must be emphasised that both inborn dispositions (genetic or stimulated in prenatal development) and early musical training contribute to the development of absolute pitch. This ability correlates positively not only with proficiency in performing musical tasks, but also with cognitive skills, such as attention (Wilson et al., 2009) and memory span (Deutsch & Dooley, 2013), which might explain the existence of more complex neural networks within musicians' brains (Wilson et al., 2009). Oeschslin et al. (2010) points out that both practising music professionally and developing absolute pitch lead to considerable changes in the gray matter, mainly in the regions important for speech processing, which is processed more efficiently by individuals with absolute pitch. What is more, absolute pitch is associated with hyperconnectivity (a greater number of direct connections or a more complex network of connections between the regions responsible for perception and categorisation), which might contribute to an increased efficiency in cognitive tasks performance (Loui et al., 2011).

The research presented above explains why long-term changes in the brain might correlate with the specifics of the information processing, learning, and problem solving typical for musical training. It cannot be also precluded that cognitive processes associated with musical training influence other functions, ones directly unrelated with music, e.g. an insight into important aspects of the self. In the learning process, a music student gains experience, which contributes to brain plasticity, and expands the unique inner world of the self (Pąchalska et al., 2014). In the next section, the analysis of cognitive functioning in the context of musical behaviour will be restricted to metaknowledge about the influence of psychological laws on one's own behaviour.

An attempt to define the metacognitive self

One of the most famous maxims of Socrates was 'know thyself'. Certainly, knowing oneself is extremely beneficial and allows an individual, among other things, to avoid mistakes and make the best choices. Nowadays, we know that it is a human propensity to ponder on different states of mind and to reflect on one's self (Brycz et al., 2014; Moskowitz, 2005; Povinelli, 1993). Psychologists

call this ability an insight into one's own thinking, that is metacognitive thinking (Flavell, 1979). The functions of metacognitive self-judgements include investigating the motives of one's own behaviour and gaining insight into one's own cognitive processes (Pąchalska et al., 2014), as well as comparing the effects of one's own and other people's cognitive functioning (Brycz et al., 2014). As the representation of one's cognition might play a vital role in the processes of self-regulation, metacognition is one of the most important subjects of study in psychology (Nelson, 1992).

One of the first European philosophers, Thales of Miletus, already noticed that one of the most difficult thing for a human is 'to know thyself'. Human investigation into states of mind deviate from rationality. One may try to know oneself accurately and adequately, but it is uncommon to gain such an insight. On the one hand, people make simple observations about themselves, such as 'I'm shy' (judgements of the first order). On the other hand, in considering themselves, they analyse if they have made inaccurate self-judgements in the past and if so, how often this has happened ('Am I really shy?') (Brycz et al., 2014). This brings us to metacognitive judgements. Judgements of the second order, referring to laws governing behaviour, are called the metacognitive self (Brycz et al., 2014). The term denotes a type of self-knowledge associated with an accurate or inaccurate insight into the self. The metacognitive self depends on the accuracy of understanding the link between one's own behaviours and the errors resulting from biases and psychological mechanisms (Brycz et al., 2014).

Thus, highly accurate self-perception is associated with the ability to recognise bias in one's own actions, reasoning, and judgement. The bias in one's functioning might refer to a susceptibility to persuasion, irrationality in thinking and judgement, memory functioning, processes of evaluation, social influence, and ethical self-knowledge (Brycz & Karasiewicz, 2011a). Individuals with a low level of metacognitive self refuse to acknowledge that they too succumb to common psychological bias (Brycz & Karasiewicz, 2011a). Hence, not everybody perceives the bias in their behaviour with the same level of accuracy. It means that for some reasons some individuals are more successful in identifying how psychological biases affect their behaviour, while others fail to acknowledge this influence (Brycz & Karasiewicz, 2011b). Previous research has suggested that people tend to differ in their awareness of deviations from rationality in their thinking. Thus, it is worth examining which individual traits determine the variability in the strength of the metacognitive self. So far it has been impossible to assess, to what extent the variables associated with undergraduate musical training influence accuracy in self-perception.

The aim of the study

Metacognitive strategies are essential for all aspects of musical training. Having said that, we can analyse metaknowledge in detail and link it to specific behaviours and musical problems. Strategies could be also related to the behaviours associated with the long-term control of one's cognitive processes. In the light of the

conducted analysis, it seems reasonable to assume that musicians possess a different set of self-regulatory behaviours than individuals who do not play any musical instrument whatsoever (cf. Hallam, 2001). Since musicians, besides the standard education common to all students (children and teenagers), attend extracurricular, evening music classes, we expect to find in them a distinct and more accurate insight into self, which might result from the deliberate planning, analysis and evaluation of the learning process and the outcomes of the training. Obviously, the development of the metacognitive self could depend on the duration of musical training. Therefore, more advanced undergraduate music students may exhibit a more developed metacognitive self and evaluate their achievements more accurately as well as be more aware of their technical, interpretative and performance problems. In contrast, beginners and individuals uneducated in music might score lower on metacognitive self tests.

To conclude, the current study aimed to answer the question: 'Is musical training associated with a different level of the accuracy of perception of one's own irrationality?' to operationalise the research question more precisely, the following hypotheses were formulated:

1. The accuracy in the perception of one's own irrationality is presumably higher in musicians than in controls.
2. The accuracy in the perception of one's own irrationality is associated significantly with the intensity of musical training – the longer and the more intense the musical training, the greater the musician's accuracy.

MATERIALS AND METHODS

Sociodemographic data was collected with a questionnaire constructed for the purpose of the study. The accuracy in the perception of one's own irrationality was assessed with the MJ-40 Scale (Brycz & Karasiewicz, 2011a). The sociodemographic questionnaire comprised questions about age, sex, the duration of musical training, the average number of hours spent on practice, the proportion of time spent on reading sheet music and improvising, as well as the type of musical behaviour (being a vocalist or an instrumentalist, a soloist or a non-soloist).

The MJ-40 Scale measures the accuracy in the perception of irrationality in one's own thinking and behaviour, i.e. the biased judgement of one's own reasoning and actions (Brycz & Karasiewicz, 2011a). The Scale of Metacognitive Self (MJ-40) has been proved to be a highly accurate and reliable tool. A confirmatory factor analysis has been conducted to assess the accuracy and reliability of the measurement of the metacognitive self. The results indicated that in a population of musicians the assessment of irrationality in judgement and self-perception is accurate ($\chi^2(38)=45.624$; $p=.186$; $RMSEA=.028$), and the theoretical model of metacognitive self measurement provides an explanation for approximately 59% of the variability of results ($AVE=.592$) with a high degree of reliability.

Variables and their operationalisation

The presented research model tested two types of variables – independent and dependent. The accuracy in the perception of one's own irrationality, measured by the MJ-40 Scale (Brycz & Karasiewicz, 2011a), is the dependent variable. Independent variables include engagement in musical behaviour or the status of a musician and its specific features: the type of musical behaviour (being a vocalist or an instrumentalist), the position in a band (being a soloist or a non-soloist), the duration of musical training, and the amount of time dedicated to daily practice, both in terms of improvising and reading sheet music.

Participants and procedure

To collect data, a technique of computer-assisted personal interviewing (CAPI) was adopted in the study. The participants logged through a computer browser onto a website containing the questionnaire form and the MJ-40 Scale. The musically experienced group comprised students of the Academy of Music in Gdansk, and the inexperienced group included musically untrained students from different faculties, recruited at the University of Gdansk and the Gdansk University of Technology.

The sample comprised N = 316 participants aged from 16 to 41 (M=22.1; SD=2.90), more than a half being younger than 21.5. N = 130 participants (41.1% of the sample) were musically inexperienced, 41.8% (N = 132) were male, and the two analysed groups (musicians and controls) slightly differed in terms of sex ratio ($\chi^2(1)=3.609$; p=.057; C_C=.113) – men, who outnumbered women in the control group (48.5%), were in minority (37.1%) in the group of musicians.

The age of the participants was similar in both compared groups (Z = -1.492; p = .136; ε= .01), with the average musician being between 20 and 24 (M = 22.2; SD = 2.1), and most controls between 19 and 25 (M = 22.1; SD = 3.4).

The tested musicians reported from 3 to 24 years of musical training (M = 12.22; SD = 13.0), and half of the group had learned music for less than 13 years. The average time dedicated to daily practice ranged from 1 to 5 hours, and again, half of the participants spend less than 3 hours on training (M = 2.70; SD = 1.11), improvising for 32% of that time at most (M = .32; SD = .27).

Table 1. Sex ratio in the sample

Sex	Musical behaviour		Altogether
	Controls	Musicians	
M	63	69	132
	48.5%	37.1%	41.8%
F	67	117	184
	51.5%	62.9%	58.2%
Altogether	130	186	316
	100%	100%	100%

RESULTS

The following section presents the results of the analyses which were conducted to estimate the significance of the tested hypotheses. The analyses were performed with SPSS software licensed for the University of Gdansk.

Difference between musicians and controls in the accuracy in the perception of one's own irrationality

To test the first hypothesis, predicting a different level of metacognitive self in the compared groups, an independent samples t-test was performed. The null hypothesis was confirmed as no significant differences were found between the groups in the level of metacognitive self.

The results of the conducted analysis indicate that the accuracy of self-perception, i.e. the level of metacognitive self development, does not distinguish musicians from controls. In the two groups results pertaining to metacognitive self were comparable for all dimensions, irrespective of the musical status of the participants.

To test the second hypothesis, a multiple regression analysis was performed. The coefficient of the determination R^2, shows to what extent the result of the multiple regression explains the variability of the dependent variable (Brzeziński, 1996). In the tested model, the variables pertaining to musical training – the duration of musical training, the number of hours spent on daily practice, and sex – were included in the group of predictor variables of the metacognitive self and its indicators. The analysis included only the data obtained from the musicians sample, excluding the data collected in the comparison group.

The results indicate that of all the predictor variables sex explains more variation and allows one to predict the level of metacognitive self development and the level of its indicators more accurately than the musical factors. Moreover,

Table 2. An overview of the results of the analysis assessing the significance of differences between musicians and controls

Dependent variable	Controls			Musicians			Test of the statistical significance of mean differences		
	M	SD	N	M	SD	N	t(314)	p	d
Perception of being influenced by peripheral route of persuasion	7.02	1.33	130	7.04	1.17	186	-.158	.875	-.02
Perception of one's own irrationality in thought, judgement and behaviour	6.07	1.31	130	6.19	1.10	186	-.881	.379	-.10
Accuracy of perception of memory and social judgement bias	6.65	1.47	130	6.84	1.37	186	-1.170	.243	-.14
Susceptibility to social influence	4.88	1.49	130	5.00	1.34	186	-.779	.437	-.10
Susceptibility to affective inconsistency	2.88	1.69	130	2.87	1.76	186	.062	.951	.01
Metacognitive self – overall score	5.50	1.00	130	5.59	.87	186	-.841	.401	-.09

[A]p<.10; *p<.05; **p<.01; ***p<.001

the positive values of the regression coefficients show that women score significantly higher in the measurement of the metacognitive self and its indicators. The most marked difference between the male and female participants concerns the indicator of the accuracy in the perception of one's susceptibility to a peripheral route of persuasion (β= .27; p<.001), which accounts for 27% of the standard deviation of the results of the metacognitive self measurement.

The least significant of the determinants influencing the level of metacognitive self was the age of the musicians, which correlates slightly with the accuracy in the perception of the irrationality of memory and social judgement biases – the older the participants, the less accurately they perceived their lack of rationality in judgement.

The results of the analysis testing the influence of the musical factors on the level of metacognitive self might allow for a validation of the hypothesis stated in the current study. The duration of musical training explains 6% of the variation in the measurement of the metacognitive self, while the number of hours dedicated to everyday musical practice – about 7.2% from the overall 14% of the explained metacognitive self variation. The correlation between these two musical independent variables and the level of metacognitive self is positive, which means that the more experienced the musicians and the more frequently they improvise during musical training, the more accurately they recognise their irrationality and biases in thinking and judgements. Finally, it must be mentioned that due to the extremely small impact of the variables associated with the type

Table 3. The summary of the results of multiple regression, measuring the influence of sociodemographic factors on the development of the metacognitive self

Dependent variable	Sex		Age		Duration of training		Time dedicated to improvising		Variation explained	
	β	p	β	p	β	p	β	p	R^2	p
Perception of being influenced by peripheral route of persuasion	.27***	<.001	.05	.398	-.03	.617	.05	.468	.17***	<.001
Perception of one's own irrationality in thought, judgement and behaviour	.15**	.009	-.13*	.027	.24*	.031	.33*	.017	.09**	.007
Accuracy of perception of memory and social judgement biases	.19**	.001	.07	.246	.26*	.035	.27*	.029	.11**	.002
Susceptibility to affective inconsistency	.07	.210	-.12*	.036	.14*	.030	.14*	.030	.04*	.014
Susceptibility to social influence	-.01	.805	-.05	.423	-.04	.512	.06	.352	<.01	.781
Metacognitive self – overall score	.15[A]	.051	-.03	.689	.30*	.028	.36*	.014	.14**	.008

[A]p<.10; *p<.05; **p<.01; ***p<.001

of musical behaviour, such as being a soloist or playing in a band (a non-soloist), playing an instrument or being a vocalist, these factors have been excluded from further analyses.

DISCUSSION

The conducted exploratory research aimed to test two hypotheses: a) musicians and controls differ significantly in their level of metacognitive self, and b) musical training and musical experience facilitate the accuracy of the perception of one's own irrationality. The results of the analysis performed indicate that in terms of the accuracy in the perception of one's own irrationality and metacognitive self functioning, only insignificant differences can be observed between musicians and controls in a similar age and of the same sex. Thus, the findings allow for a rejection of the first hypothesis. At the same time, the results confirm the second hypothesis, indicating that musical experience enhances significantly the accuracy in the perception of one's own irrationality. The number of years dedicated to musical training and the amount of time spent improvising during everyday musical practice, encourage a more frequent reflection on cognitive processes, which leads to an improvement in the accuracy of recognising one's own irrationality.

Despite the assumption that musical behaviour should promote awareness of one's irrationality, students of faculties other than music scored similarly on the metacognitive self test. The obtained result corresponds with the findings of Wilsz (2012), who based her research on the assumption that regular attendance of music classes influences metacognitive development. She defined it as an ability to employ adaptive strategies in learning. In the cited study, no statistically significant differences were found between individuals performing music and their musically inactive counterparts. There are several possible explanations for the result. The musically untrained sample might have generally had a well-developed metacognition (cf. Wilsz, 2012) and metacognitive self. However, this explanation is called into question by the results of large samples research, which reveal the same pattern: although when it comes to observing other people, subjects have impressive knowledge about the psychological laws at work, they are unable to apply these to themselves (Brycz, 2004; Brycz, 2012).

The results of the current study might also point to the fact that university education itself promotes metacognitive thinking and develops the metacognitive self. Studying at university contributes to the development of reflectivity, which enhances further academic achievement, both in the social and cognitive domain. The authors of the MJ-40 Scale assume that educational work and deliberate educational measures might develop the accuracy of self-perception (Brycz & Karasiewicz, 2011a). What confirms this thesis are findings showing a significant correlation of the MJ-40 Scale score and academic qualifications (Brycz & Karasiewicz, 2011a). Moreover, a high score on the metacognitive self test was more often observed in women than men, a result interpreted by the authors of

the scale as evidence for a greater inclination amongst young, well-educated women towards introspection (cf. Brycz & Karasiewicz, 2011a). What is noteworthy, the most pronounced difference between the male and female participants was revealed in a subscale measuring the perception of one's own susceptibility to a peripheral route of persuasion. The result implies that women recognize more accurately their tendency to change attitude, judgements and intentions of behaviour in response to persuasion based on the emotional line of reasoning.

It seems that the factor contributing to the accuracy in self-perception is the wealth of experience which comes with age and e.g. work practice (cf. Brycz & Karasiewicz, 2011a) or, in the case of musicians, with years of musical training. In the current study the accuracy in the perception of one's own irrationality, biases in thinking, and judgement correlated positively with musical experience. This assumption is supported by previous studies, which show significant differences between novice and proficient musicians in their knowledge and application of various strategies in training (Jørgensen, 2009). Novice musicians do not manifest complex strategic behaviour, which is associated with musical experience (Hallam & Barry, 2002). Importantly, training strategies are an essential feature of metaknowledge, (Jørgensen, 2009). Using appropriate strategies, e.g. making decisions strategic for playing, detecting and correcting errors, memorising music, evaluating the results of the training, preparing for a performance, involves asking the following questions: Are these strategies really effective for me? If not, is it the case only in some or all aspects of the training? Have I known that they would be ineffective? What will happen if I modify or change the strategy? How long will I be using it if it doesn't work? What will make me change it? Perceiving and accepting feedback on what I do and how I do it, recognition and modification of the accuracy of one's own evaluations and actions, can be observed in individuals who have undergone a long-term musical training. In the present study, these capacities correlate with the level of metacognitive self. If we define metacognitive self as an ability to recognize one's own mistakes, it can be seen as a relatively changeable individual trait.

The obtained results correspond interestingly with the assumptions of Hallam's interactive model of training (1997). The model shows that the results of a learning process, determined by the engagement in musical training, which is reflected e.g. in the amount of time devoted to it, influences not only the student's skills, but also their self-knowledge. What changes, are the ways and the strategies of practice, the aims and the content of performance and musical interpretation, and the knowledge about one's own cognitive processes, in other words, metacognition. In this case, according to Hallam, the variable mediating between the engagement in musical training on the one hand and increasing skills and metacognition on the other is the student's attribution process. This has been further supported by the theoretical concepts proposed by social psychologists who claim that metacognitive self-beliefs are formed on the basis of attribution, i.e. the mechanisms of explaining the causes of behaviour (cf. Brycz et al., 2014).

Several types of attribution have been distinguished in music, including different types of effort, nervousness, happiness, task difficulty (McPherson & McCormic, 2000), musical background, school classroom, musical abilities, and music enjoyment (Asmus, 1986).

The results of the current study are interestingly complemented by those findings indicating that the greater amount of time devoted to improvisation during everyday musical practice correlates positively with the development of the metacognitive self. In music, improvising is considered thinking outside the box, which makes it a spontaneous process, precluding rational analysis, self-criticism, and the sense of time (cf. the flow phenomenon, Csikszentmihalyi & Rich, 1997). Nevertheless, metacognition can play a vital role in the creation of innovative ideas, concepts and the performing of new actions, as it is a cognitive process which is involved in the verification of previously generated ideas: new compositional solutions, unusual expansions of a musical theme etc. In the process of creation one deals with the question: 'To what extent have my previous appraisals of my ideas been relevant, and to what extent have they been deviated from rationality (biased, e.g. based on the illusion of control)? A man who is aware that his judgement is biased, and as such is not relevant, has a high level of metacognitive self. Interestingly, the brain regions related to metacognition also activate during the performance of creative tasks, such as divergent thinking, writing (eg. novels & poetry), and musical improvisation (Fox & Christof, 2014).

The presented research might provide an answer to questions regarding the processes of self-perception, as it analyses self-knowledge in the context of the cognitive processes related to musical training. The merit of the study is the timeliness of the problems it examines. The mechanisms of the influence of the metacognitive self on cognition have not been fully described yet, and the concept of the metacognitive self is still being developed. Reviewing previous research on strategies in musical training, Jørgensen suggests that further scientific research is mostly needed into the domain of the mind, not into the technical strategies of musicians (Jørgensen, 2009). It is this domain that offers students the greatest opportunities for improvement. Jørgensen's observation is linked to the problem of the application of the results, which is associated with the individual development of the metacognitive self. In this respect, it is essential to determine to what extent the metacognitive self can be developed through training (cf. Brycz & Karasiewicz, 2011a). What makes the question so important is the fact that the metacognitive self probably facilitates self-regulation in terms of perseverance, e.g. the ability to perform tasks requiring a large attention span (Brycz et al., 2014), which is strategic for musical activity (Hallam, 1995; Hallam, 2001). Moreover, Hallam suggests that a metaknowledge about one's tendencies to make certain types of errors allows one to select a relevant remedial strategy, which might contribute to musical proficiency (Hallam, 1995; Hallam, 2001).

On the basis of the obtained results, it can be assumed that if certain forms of musical activity are repeated in individual experience frequently enough, they might become an important correlate of the metacognitive self. The analysed

findings might derive from the recurrence of the objective parameters of situations in which an individual person functions combined with the relative consistency of external factors, conditioning subjective parameters. From this perspective, data pertaining to the consistency of the metacognitive self in time as well as data on the performance of different tasks by the same individuals, would be of value. However, addressing this problem requires further, broad, longitudinal study.

In further studies, it is worth analysing the distribution of the strength of metacognitive self in a sample of musically active individuals. The premises for conducting such research are two facts: a) the lack of differences between musicians and controls, and b) a significant relation between the engagement in musical training and the metacognitive self. Both findings suggest that a group of individuals dedicated to musical training (practising more intensely and for a longer period of time) might differ in the strength of the metacognitive self to a greater degree than a group of musically untrained individuals, and the strength of the metacognitive self may depend on factors associated with learning music.

CONCLUSIONS

The present study not only shows the current state of our knowledge about the metacognitive self, but it also proposes an extension of the concept, as it encourages further analyses from the perspective of psychology, education, and neuropsychology. The authors point out new research fields and attempt to inspire further studies, such as longitudinal research monitoring the development of the metacognitive self within the context of further training or motivational and personality factors. The conclusions presented require further, in-depth, empirical analyses.

REFERENCES

Altenmüller, E. (1989). Cortical DC-potentials as electrophysiological correlates of hemispheric dominance of higher cognitive function. *International Journal of Neuroscience*, 47, 1–14.

Altenmüller, E. (2003). How many music centres are in the brain? (In): I. Peretz, R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp. 346-356). Oxford: Oxford University Press.

Anvari, S. H., Trainor, L. J., Woodside, J., Levy, B. A. (2002). Relations among musical skills, phonological processing, and early reading ability in preschool children. *Journal of Experimental Child Psychology*, 83, 111-130.

Asmus, E. P. (1986). Achievement motivation characteristics of music education and music therapy students as identified by Attribution Theory. *Council for Research in Music Education Bulletin*, 86, 71-85.

Brycz, H. (2004). *Trafność spostrzegania własnych i cudzych zachowań*. Kraków: Oficyna Wydawnicza Impuls.

Brycz, H. (2012). *Człowiek – instrukcja obsługi*. Sopot: Smak Słowa.

Brycz, H., Karasiewicz, K. (2011a). *Skala Metapoznawczego Ja*. Kraków: Oficyna Wydawnicza Impuls.

Brycz, H., Karasiewicz, K. (2011b). Metacognition and self-regulation: the Metacognitive Self Scale. *Acta Neuropsychologica*, 9(3), 263-282.

Brycz, H., Karasiewicz, K., Klimaszewska, J. (2014). Współzależność metapoznawczego Ja i wybranych aspektów funkcjonowania poznawczego. *Polskie Forum Psychologiczne,* 19(3), 421-428.

Brzeziński, J. (1996). *Metodologia badań psychologicznych*. Warszawa: Wydawnictwo Naukowe PWN.

Caldwell, G. N., Riby, L. M. (2007). The effects of music exposure and own genre preference on conscious and unconscious cognitive processes: A pilot ERP study. *Consciousness and Cognition*, 16, 992-996.

Chan, A. S., Ho, Y. C., Cheung, M. C. (1998). Music training improves verbal memory. *Nature*, 396(6707), 128–128.

Costa-Giomi, E. (2005). Does music instruction improve fine motor abilities? *Neurosciences and Music II: From Perception to Performance*, 1060, 262–264.

Csikszentmihalyi, M. Rich, G. (1997). Musical improvisation: A systems approach. (In): R. K. Sawyer (Eds.), *Creativity in performance* (pp. 43-66). Greenwich, CT: Abex.

Czerniawska, E. (2012). Czy słuchanie muzyki może wspomóc procesy poznawcze? (In): E. Czerniawska (Eds.), *Muzyka i my. O różnych przejawach wpływu muzyki na człowieka* (pp. 69-88). Warszawa: Difin.

Degé, F., Wehrum, S., Stark, R., Schwarzer, G. (2014). Music lessons and academic self-concept in 12- to 14-year-old children. *Musicae Scientiae*, 18(2), 203-215.

Deutsch, D., Dooley, K. (2013). Absolute pitch is associated with a large auditory digit span: A clue to its genesis. *Journal of the Acoustical Society of America*, 133(4), 1859–1861.

Elbert, T., Pantev, C., Wienbruch, Ch., Rockstroh, B., Taub, E. (1995). Increased cortical representation of the fingers of the left hand in string players. *Science*, 270(5234), 305-307.

Fauvel, B., Groussard, M., Chételat, G., Fouquet, M., Landeau, B., Eustache, F., Desgranges, B., Platel, H. (2014). Morphological brain plasticity induced by musical expertise is accompanied by modulation of functional connectivity at rest. *NeuroImage*, 90, 179-188.

Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. *American Psychologist,* 34, 906-911.

Fox, K. C., Christoff, K. (2014). Metacognitive facilitation of spontaneous thought processes: When metacognition helps the wandering mind find its way. (In): S. M. Fleming, Ch. D. Frith (Eds.), *The cognitive neuroscience of metacognition* (pp. 293-320). New York: Springer.

Gardner, H. (1973). *The arts and human development*. New York: Wiley.

Gordon, E. E. (1997). *A music learning theory for newborn and young children*. Chicago: GIA Publications.

Hallam, S. (1995). Professional musicians' approaches to the learning and interpretation of music. *Psychology of Music*, 23(2), 111-128.

Hallam S. (1997). What do we know about practising? Towards a model synthesising the research literature. (In): Jørgensen H., Lehman A. (Eds.), *Does practice make perfect? Current theory and research on instrumental music practice* (pp. 179–231). Oslo, Norway: Norges musikkhgskole.

Hallam, S. (2001). The development of metacognition in musicians: Implications for education. *The British Journal of Music Education*, 18(1), 27-39.

Hallam, S., Barry, N. H. (2002). Practice. (In): R. Parncutt, G. McPherson (Eds.), *The science and psychology of music performance: Creative strategies for teaching and learning* (pp. 151-165). Oxford: Oxford University Press.

Jakobson, L. S., Lewycky, S. T., Kilgour, A. R., Stoesz, B. M. (2008). Memory for verbal and visual material in highly trained musicians. *Music Perception*, 26(1), 41–55.

Jørgensen, H. (2009). Czy ćwiczenie czyni mistrza? Przegląd badań nad ćwiczeniem. (In): B. Kamińska, M. Zagrodzki (Eds.), *Ćwiczenie w rozwoju i działalności muzyka wykonawcy. Teoria-badania-praktyka* (pp. 51-73). Warszawa: Wydawnictwo Uniwersytetu Muzycznego Fryderyka Chopina.

Kantor-Martynuska, J. (2009). The listener's temperament and perceived tempo and loudness of music. *European Journal of Personality*, 23(8), 655-673.

Lawendowski, R. (2011). *Osobowościowe uwarunkowania preferencji muzycznych w zależności od wieku*. Kraków: Oficyna Wydawnicza Impuls.

Lawendowski, R., Basiński, K., Karasiewicz, K. (2014). Strategies of rhythm perception in developmental dyslexia. *Acta Neuropsychologica*, 12(3), 305-317.

Loui, P., Li, H. C., Hohmann, A., Schlaug, G. (2011). Enhanced cortical connectivity in absolute pitch musicians: A model for local hyperconnectivity. *Journal of Cognitive Neuroscience,* 23(4), 1015–1026.

McPherson, G. E., McCormick, J. (2000). The contribution of motivational factors to instrumental performance in a music examination. *Research Studies in Music Education*, 15, 31-39.

Moskowitz, G. (2005). *Social Cognition. Understanding self and others.* NY, London: The Guilford Press.

Musacchia, G., Sams, M., Skoe, E., Kraus, N. (2007). Musicians have enhanced subcortical auditory and audiovisual processing of speech and music*. Proceedings of the National Academy of Science*, 104(40), 15894-15898.

Münte, T., Altenmüller, E., Jäncke, L. (2002). The musician's brain as a model of neuroplasticity*. Nature Reviews Neuroscience,* 3(6), 473-478.

Nelson, T. O. (1992). *Metacognition: Core readings.* Boston: Allyn & Bacon.

Oechslin, M. S., Meyer, M., Jäncke, L. (2010). Absolute pitch: functional evidence of speech - relevant auditory acuity. *Cerebral Cortex*, 20(2), 447–455.

Ohnishi, T., Matsuda, H., Asada, T., Aruga, M., Hirakata, M., Nishikawa, M., Katoh, A., Imabayashi, E. (2001). Functional anatomy of musical perception in musicians. *Cerebral Cortex*, 11(8), 754-60.

Pantev, C., Oostenveld, R., Engelien, A., Ross, B., Roberts, L., Hoke, M. (1998). Increased auditory cortical representation in musicians. *Nature*, 392, 811 – 814.

Pantev, C., Engelien, A., Candia, V., Elbert, T. (2001). Representational cortex in musicians: Plastic alterations in response to musical practice. *Annals of the New York Academy of Sciences*, 930, 300-314.

Pantev, C., Engelien, A., Candia, V., Elbert., T. (2003). Representational cortex in musicians. (In): I. Peretz, R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp.382-395). New York: Oxford University Press.

Pąchalska, M., Kaczmarek, B. L. J., Kropotov, J. D. (2014). *Neuropsychologia kliniczna. Od teorii do praktyki*. Warszawa: PWN.

Povinelli, D. J. (1993). Reconstructing the evolution of mind. *American Psychologist,* 48, 493-509.

Rauscher, F. H., Hinton, S. C. (2006). The Mozart effect: Music listening is not music instruction. *Educational Psychology*, 41(4), 232-238.

Rentfrow, P., Gosling, S. (2003). The do re mi's of everyday life: The structure and personality correlates of music preferences. *Journal of Personality and Social Psychology*, 84, 1236-1256.

Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological Science*, 15(8), 511–514.

Schellenberg, E. G. (2006). Exposure to music: The truth about the consequences. (In): G. E. McPherson (Eds.), *The child as musician: A handbook of musical development* (pp. 111–134). New York: Oxford University Press.

Schlaug, G., Jäncke, L., Huang, Y., Staiger, J., Steinmetz, H. (1995a). Increased corpus callosum size in musicians*. Neuropsychologia*, 33(8), 1047-1055.

Schlaug, G., Jäncke, L., Huang, Y., Steinmetz, H. (1995b). In vivo evidence of structural brain asymetry in musicians. *Science*, 3 (267), 5198, 699–701.

Schneider, P., Scherg, M., Dosch, H., Specht, H., Gutschalk, A., Rupp, A. (2002). Morphology of Heschl's gyrus reflects enhanced activation in the auditory cortex of musicians. *Nature Neuroscience*, 5(7), 688 – 694.

Seung, Y., Kyong, J. S., Woo, S. H., Lee, B. T., Lee, K. M. (2005). Brain activation during music listening in individuals with or without prior music training. *Neuroscience Research*, 52, 323-329.

Tierney, A., Bergeson, T. R., Pisoni, D. (2009). General intelligence and modality-specific differences in performance: A response to Schellenberg. *Empirical Musicology Review*, 4(1), 37-39.

Vaughn, K. (2000). Music and mathematics: Modest support for the oft-claimed relationship. *Journal of Aesthetic Education*, 34(3–4), 149–166.

Weinberger, N., Bakin, J. (1998). Research on auditory cortex plasticity. *Science*, 280(5367), 1174.

Wetter, O. E., Koerner, F., Schwaninger, A. (2009). Does musical training improve school performance? *Instructional Science*, 37(4), 365–374.
Wieser, H. (2003). Music and the brain. Lessons from brain diseases and some reflections on the "emotional" brain. *Annals of New York Academy of Sciences,* 999, 76-94.
Wilson, S. J., Lusher, D., Wan, K. Y., Dudgeon, P., Reutens, D. C. (2009). The neurocognitive components of pitch processing: Insights from absolute pitch. *Cerebral Cortex*, 19(3), 724–732.
Wilsz, N. (2012). Czy uprawianie muzyki ma korzystny wpływ na procesy poznawcze, strategie uczenia się i osiągnięcia w nauce? (In): E. Czerniawska (Eds.), *Muzyka i my. O różnych przejawach wpływu muzyki na człowieka* (pp.145-160). Warszawa: Difin.

Address for correspondence:
Rafał Lawendowski
Institute of Psychology
University of Gdańsk
Bażyńskiego 4 str.
80-952 Gdańsk, Poland
e-mail: r.lawendowski@ug.edu.pl