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Moral development, executive functioning, peak experiences and brain patterns in professional and amateur classical musicians: Interpreted in light of a Unified Theory of Performance

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ABSTRACT

This study compared professional and amateur classical musicians matched for age, gender, and education on reaction times during the Stroop color-word test, brainwaves during an auditory ERP task and during paired reaction-time tasks, responses on the Gibbs Sociomoral Reflection questionnaire, and self-reported frequencies of peak experiences. Professional musicians were characterized by: (1) lower color-word interference effects (Stroop task), (2) faster categorization of rare expected stimuli (P3b), and a trend for faster processing of rare unexpected stimuli (P3a), (3) higher scores on the Sociomoral Reflection questionnaire, and (4) more frequent peak experiences during rest, tasks, and sleep. Both groups had high values on the Brain Integration Scale. These findings are interpreted in light of a Unified Theory of Performance, which posits that effectiveness in any area is influenced by one's level of mind-brain development—emotional, cognitive, moral, ego and cortical development—with higher mind-brain development supporting greater effectiveness in any domain.

1. Introduction

Success in any field is determined by natural inborn talent shaped by ongoing experience. Levitin and colleagues report that accomplished musicians practice longer hours than musicians who are not at the top; the best conservatory students practice up to twice as much as those who were not judged as accomplished; and musicians, who achieve the highest performance ratings over time, practiced the most, irrespective of how much "talent" they possessed (Levitin, 2006).

The relation of practice to top performance is consistent with what is known with how the brain learns. The term *neuroplasticity* is used to describe the brain's ability to adapt and change as a result of training and experience over the course of a person's life. Through repeated experience we create neural circuits that support smooth, automatic flow of behavior. Neuroplasticity includes both increasing the number of connections and increasing the myelin sheath around each axon, which speeds up information flow (Fields & Stevens-Graham, 2002; Stevens, Porta, Haak, Gallo, & Fields, 2002). For instance, experience of music and language enhance brainstem representation of sound, supporting improved perceptual abilities to distinguish a signal from back ground noise (Song, Skoe, Banai, & Kraus, in press). Playing an instrument in an ensemble primes the brain to choose what is relevant in a complex situation that involves reading or remembering a score, timing issues and coordination with other musicians (Kraus & Chandrasekaran, 2010). Voxel-by-voxel comparison of gray matter (structural MRI) in professional keyboard players and matched amateur musicians revealed differences in motor as well

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as auditory and visuospatial brain regions, with greater structural differences in musicians who began learning music at a younger age (Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995; Schlaug, Norton, Overy, & Winner, 2005), and who practiced with greater intensity (Gaser & Schlaug, 2003; Hutchinson, Lee, Gaab, & Schlaug, 2003; Schneider et al., 2005).

In addition, sensorimotor functioning is enhanced in musicians. Music training can strengthen connections between auditory and motor regions while activating multimodal integration regions. Training of this neural network may produce cross-modal effects on other behavioral or cognitive operations that draw on this network (Wan & Schlaug, 2010). Compared to non-musicians, musicians possess better control of finger movements (Kincaid, Duncan, & Scott, 2002) and detect changes in the pitch of sound faster and more accurately than non-musicians. The amplitude of event-related potentials (ERP), a brain measure of speed of processing, is reported larger in musicians 200 ms after the stimulus (N200), which indexes stimulus evaluation, and 300 ms after the stimulus (P300), which indexes categorization of stimuli (Nikjeh, Lister, & Frisch, 2009; Tervaniemi, Just, Koelsch, Widmann, & Schroger, 2005).

While most research has investigated specific effects of music practice, studies have also reported differences between professional and amateur musicians in overall brain functioning. Frontal brain areas—involved in planning, guiding mental and behavioral sequences, and controlling responses—are more extensively activated during performance in professional musicians compared to non-musicians (Munte, Nager, Beiss, Schroeder, & Altenmuller, 2003). Functional MRI studies revealed reduced brain activation during motor tasks in piano players compared to control subjects in the primary, premotor, and supplementary motor cortex (Hund-Georgiadis & von Cramon, 1999; Jancke, Shah, & Peters, 2000; Krings et al., 2000; Meister et al., 2005). This was explained in terms of more efficient wiring leading to lower neural activation (Bangert et al., 2006; Jancke et al., 2000; Krings et al., 2000).

Overall brain functioning has been conceptualized in a Unified Theory of Performance as "mind-brain development" (Harung, Alexander, & Heaton, 1995). During the first three decades of life, mind-brain development is affected by natural brain maturation interacting with ongoing experience. After age 30 years, experience is the major factor in changing brain structure and functioning (Toga, Thompson, & Sowell, 2006). Continuous brain development is considered to underlie cognitive, emotional, moral and ego development (Harung, 1999; Travis & Brown, 2011).

One marker of mind-brain development is brain integration. Higher brain integration provides a coherent framework for the brain to integrate localized processing modules into a larger picture (Palva & Palva, 2007). Brain integration has been operationalized by three EEG-derived measures recorded during challenging tasks: broad band frontal coherence, relative global alpha power, and brain preparatory response during challenging tasks (Travis, Tecce, Arenander, & Wallace, 2002). These three brain measures have been combined into a Brain Integration Scale. Higher scores on the Brain Integration Scale are associated with higher activity in the frontal–parietal default mode network of the brain (Travis et al., 2010), which is reported to underlie general intelligence (Glascher et al., 2010). Higher scores on the Brain Integration Scale correlate positively with higher emotional stability, higher moral reasoning, and more openness to experience; and correlates negatively with anxiety (Travis, Arenander, & DuBois, 2004).

Another marker of mind-brain development is moral reasoning. Higher moral reasoning requires a larger context for making moral decisions, for instance the impact of actions on others, society, and environment, rather than merely on one's own individual needs. Higher moral reasoning is associated with higher levels of cognitive and self-development (Gibbs et al., 1990) and, as just noted, with higher scores on the Brain Integration Scale (Travis et al., 2004). In terms of business, companies based on healthy human values and sound ethics are reported in the long run to outperform solely profit-driven organizations in terms of rise of share value (Collins & Porras, 2002).

A third marker of mind-brain development is frequency of peak experiences. Peak experiences are experiences of ego transcendence, glimpses of higher consciousness lying beyond ordinary daily experience (Alexander et al., 1990; Harung, 1999). Research with 22 world-class performers from many countries in a wide range of professions reported, "an association between world-class performance and more frequent experiences of an expanded, alert, and settled state of consciousness, even while engaged in dynamic activity" (Harung et al., 1995). Peak experiences bring with them such qualities as inner silence and deep relaxation amidst dynamic activity, ease of functioning and effortless action, playfulness, inner happiness, broad awareness combined with sharp focus, frequent luck or fortunate coincidences, reliable intuition, and sustainable performance on a high level (Alsgaard, 2008; Maslow, 1968). More frequent peak experiences have been reported by business leaders compared to non-leading controls (Thornton, Privette, & Bunderick, 1999).

Research on world-class athletes supports the relation of these three proposed markers of mind-brain development with greater effectiveness in sports. Compared to age-, gender- and type-of-sport matched average-performing athletes, 33 Norwegian world-class athletes reported (1) higher levels of self-development, (2) higher levels of moral reasoning, (3) faster electrodermal habituation to loud tones (an objective measure of the ability to ignore distractions), and (4) higher scores on the Brain Integration Scale (Harung et al., 2011). The world-class athletes in this study finished among the top ten in Olympic Games, World Championships, or similar competitions for at least three seasons.

Comparison of top-level managers and skilled knowledge workers—matched for age, gender, education, and type of organization (public or private)—reported a similar pattern of higher Brain Integration Scale scores, higher levels of moral reasoning, and more frequent peak experiences in the top-level managers. This study is now in review.

The current cross sectional study investigated whether levels of mind-brain development would differentiate professional and amateur classical musicians. Being a cross sectional study, this research cannot test causal relationships. However, it further investigates the relation of these measures in high performing populations as the basis for later longitudinal studies.

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Two additional measures were used in this study: the Stroop color-word task and an auditory event-related potential (ERP) test. In the Stroop color-word task, individuals are presented color names printed in a different-colored ink, and are asked to name the color while ignoring the word. When the font-color and word are different, they activate conflicting responses. This conflict activates a conflict monitor localized in the anterior cingulate gyrus, which in turn engages the control functions of the dorsolateral prefrontal cortex, resulting in improved performance (Carter & van Veen, 2007). Being a reliable measure of frontal executive functioning, scores on this measure will test the relation of frontal executive circuits with the three factors proposed to underlie mind-brain development—moral reasoning (scores on the Sociomoral Reflection Questionnaire), frequency of peak experiences, and scores on the Brain Integration Scale.

The auditory ERP test is considered a measure of cortical processing speed. Faster processing in auditory ERP tasks has been frequently reported in professional musicians (Nikjeh et al., 2009; Tervaniemi et al., 2005). The ERP test is used in this study as a frame of reference to generalize findings in this study to other research with musicians.

We hypothesize that professional musicians will be characterized by faster P3a and P3b latencies; that they will have lower color-word interference effects on the Stroop task and higher levels of mind-brain development as measured by: scores on the Gibbs' Sociomoral Reflection questionnaire, frequency of peak experiences, and scores on the Brain Integration Scale.

2. Method

This research focused on musicians from professional and amateur orchestras and symphonies rather than those engaged in improvisation. This was done for two reasons. First, we had support from orchestras' conductors to present the research to their musicians. Second, orchestra musicians play in a similar environment—orchestra halls with large audiences amidst many musicians in comparison with jazz musicians who might play alone or in small groups. A similar study should be conducted with jazz and other musicians who emphasize improvisation.

2.1. Subjects

Twenty-five professional classical musicians were compared to 25 amateur classical musicians. The professional musicians played in the Oslo Symphony Orchestra, the Norwegian Opera in Oslo, and Gothenburg Symphony Orchestra in Sweden. The amateurs played in various amateur symphony orchestras in Oslo, Norway, the surrounding county of Akershus, and in Gothenburg, Sweden. In addition to music, the amateur musicians were employed in a variety of professions, including pharmacy, nursing, business and management, IT-consulting, education, engineering, research, interior design, and geology. Both groups had been playing classical instruments since they were children. The professional and amateur musicians were matched for age (40.0 ± 9.5 and 40.5 ± 10.3 years, range 27–63 years) and gender (12 female and 13 male in each group). They had similar levels of education.

2.2. Procedure

Musicians volunteered to be part of the study. They came in individually for EEG recording (one hour). After completing a consent form, they filled out the Sociomoral Reflection questionnaire and the Peak Experiences Questionnaire while EEG sensors were applied. Thirty-two EEG active-sensors were applied using the BIOSEMI ActiveTwo system (www.biosemi.com). Linked ears signals were also measured for calculating an average ears reference offline. Brainwaves were digitized on line at 256 points/s and stored for later analyses using Brain Vision Analyzer. Following application of sensors, the musicians were given four computerized tasks while their EEG was recorded.

2.3. Psychological pencil and paper tests

2.3.1. Sociomoral Reflection questionnaire

Gibbs Sociomoral Reflection questionnaire (SMR-SF) – presents moral statements and asks subjects to describe *why* a moral act may be important to them. For instance: "Keeping promises is important because...", or "Helping one's friend is important because..." Gibbs has written an extensive reference manual to aid in categorizing responses into moral maturity levels (Gibbs, Basinger, & Fuller, 1992).

The SMR-SF takes 15–20 min to complete and about one hour to score. It has high test–retest reliability ($r = 0.88$), and high Cronbach alpha coefficients ($r = 0.92$). Scores on the SMR-SF are highly correlated with scores on Kohlberg's Moral Judgment Interview ($r = 0.70$) (Gibbs et al., 1992), which is much more intensive to administer and to score. Thus, scores on the Sociomoral Reflection questionnaire were used to assess moral reasoning.

2.3.2. Survey of Peak Experiences

This instrument consists of three statements describing peak experiences during eyes-closed rest, eyes-open activity, and sleep, and a fourth question about instances of luck. This measure has been created by the authors. The first three statements were derived from Eastern and Western phenomenological traditions:

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2.3.2.1. Peak experiences during rest/relaxation. ''During practice of relaxation, meditation, or prayer, or at any settled, quiet time, have you experienced a completely peaceful state; a state when the mind is very awake, but quiet; a state when consciousness seems to be expanded beyond the limitations of thought, beyond the limitations of time and space?''

2.3.2.2. Peak experiences during eyes-open tasks. ''Have you experienced that while performing activity there was an even state of silence within you, underlying and coexisting with activity, yet untouched by activity? This could be experienced as detached witnessing even while acting with intense focus''.

2.3.2.3. Peak experiences during sleep. ''During deep sleep, have you ever experienced a quiet, peaceful, inner wakefulness? You woke up fresh and rested, but with a sense that you had maintained a continuity of silent self-awareness during sleep?''

2.3.2.4. Luck or fortunate coincidences. ''Have you experienced that your desires are fulfilled in a way that seems to be caused by coincidence or luck? You may have experienced that the circumstances arrange themselves to fulfill your desires without your direct action''.

For each question the subject is asked to indicate frequency of the experience – ranging from ''never to my knowledge'' (0) to ''all the time'' (11). In addition, for each question the subjects were asked to write down sample descriptions of such experiences, using their own words to assess whether the experience accurately fits the category.

2.4. EEG protocol

EEG was recorded during four computer tasks. Instructions and practice trials preceded each computer task.

2.4.1. Paired simple reaction-time task

The first task was a 3-min paired simple reaction-time task – a warning asterisk (150 ms duration, 1 cm in height) in the center of a computer screen, followed 1.5 s later by a continuous computer-generated tone (1200 Hz, 85 dB). Subjects were asked to press the button in their right-hand as soon as they heard the tone. Brain preparatory response, or late contingent negative variation (CNV)—the height of the EEG above the baseline—was calculated in the 200 ms window before the second stimuli.

2.4.2. Paired choice reaction-time task

The second CNV task was a 4-min paired choice reaction-time task – a one- or two-digit number (150 ms duration, 1 cm in height), followed by a 1.5-s blank screen and then another one- or two-digit number (150 ms duration, 1 cm in height). Subjects were asked to press a left- or right-hand button to indicate which number was larger in value. The late contingent negative variation was again calculated during the 200-ms window before the second stimuli. Power and coherence were also calculated during this task to calculate the Brain Integration Scale.

2.4.3. Stroop color-word task

The third task was the Stroop color-word task. The Stroop color-word test yields reaction times when naming color patches (Color trials), naming color words, such as ''red'' or ''blue'' (Word trials), and reaction times when naming the color of the ink used to write the color words—such as the word ''red'' written in blue ink (Incongruent trials). Reading the word is a fast, automatic process; naming the color that the word is written in during Incongruent trials is a slow, controlled process (Stroop, 1935). The difference in reaction time in the Word trials and the Incongruent trials is called the ''color-word interference effect'' (Cohen, Dunbar, & McClelland, 1990). The color-word interference effect reflects the time to resolve competition between the fast automatic response of reading words and the slow controlled response of attending to and naming the color of the font the word is written in.

Subjects were presented five blocks of 24 trials: Color trials—randomly-ordered blue, red, green and yellow batches; Word trials – randomly-ordered words ''blue,'' ''red,'' ''green'' and ''yellow;'' and three blocks of Incongruent trials—the same four color words written in different color inks. Subjects responded by selecting a color-word underneath the probe. The block of Word trials preceded the three blocks of Incongruent trials to maximize the interference effect. Reaction time during the last block of Incongruent trials was compared to reaction time during the Word trials, since research reports that people reach an optimal level of responding after three blocks of incongruent trials (Strauss, Sherman, & Spreen, 2006).

2.4.4. Auditory novel and oddball event-related potential (ERP) protocol

The auditory novel and oddball ERP protocol investigates brain patterns in response to rare, unexpected tones—*novel* tones— presented 10% of the time, and brain patterns while counting rare, expected tones—*oddball* tones—that are also presented 10% of the time. The novel tones result in an event-related potential called the P3a, which indexes vigilance levels—timing and magnitude of stimulus-driven frontal attention mechanisms during task processing (Knight, 1996; McCarthy, Luby, Gore, & Goldman-Rakic, 1997; Polich, 2007; Potts, Liotti, Tucker, & Posner, 1996; Verbaten, Huyben, & Kemner, 1997). The oddball tones result in an ERP called the P3b, which indexes timing and magnitude of memory and stimulus categorization processes in the temporal–parietal areas associated with attention and subsequent memory processing, and is

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largest over Pz or midline parietal brain areas (Brázdil, Roman, Daniel, & Rektor, 2003; Knight, 1996; Polich, 2007; Squire & Kandel, 1999).

Subjects received 240 stimuli with one-sec inter-stimulus intervals. Ten percent (24) of the stimuli were rare, unexpected 85 dB white noise bursts (*novel* stimuli) that generated a P3a. Ten percent (24) of the stimuli were rare, expected 85 dB 1000 Hz tones (*oddball* stimuli) that generated a P3b. The other 80% of stimuli (192) were standard 85 dB 500 Hz tones, which subjects were told to ignore.

2.5. Data analysis

2.5.1. Psychological tests: Survey of Peak Experiences and the Sociomoral Reflection questionnaire

The frequency of the experience reported on the Survey of Peak Experiences was recorded. The description of their experiences was used to interpret their responses. The Sociomoral Reflection questionnaire was sent to trained scorers who returned a score between 1 and 4.

2.5.2. Performance measures: Stroop Color-Word Test

In the Stroop color-word test, total time from begin to end of each block of 24 trials was calculated. Successive stimulus was presented 100 ms following the response to the previous stimulus. Reaction time for the word trials was subtracted from the reaction time for the last of three incongruent trials to determine the color-word interference effect.

2.5.3. Brain measures: ERP and the Brain Integration Scale

In the ERP trials, data were binned by novel and oddball stimuli in 900 ms windows—100 ms before stimulus onset and 800 ms after the stimulus. There were 24 of each type of stimuli. The data were filtered with a 0.01–15 Hz window, and manually scanned for artifacts, which were removed from averaging. The latency and amplitude of the largest positivity at frontal and central midline brain areas (Fz and Cz) in a 250–550 ms window after the novel stimuli was recorded as P3a; the latency and amplitude of the largest positivity at parietal midline brain areas (Pz) in a 250–550 ms window after the oddball stimuli was recorded as P3b.

Brain Integration Scale scores were calculated as explained earlier (Travis et al., 2002), and consisted of frontal alpha coherence, frontal–central alpha relative power, and the difference in contingent negative variation in the simple and choice trials.

2.6. Statistical analyses

A between MANOVA tested group differences on 12 variables: reaction time during the Stroop Word trials, color-word interference effects, P3a amplitude and latency at Fz, and P3b amplitude and latency at Pz, the four items on the Survey of Peak Experiences, the Sociomoral Reflection questionnaire score, and the Brain Integration Scale.

An exploratory correlation analysis was also conducted to investigate relations among variables using a varimax rotation to maximize variance between variables. Age was included in this analysis since the age of the subjects spanned from 27 to 63 years.

3. Results

The between MANOVA yielded significant group differences on these 12 measures, $F(12, 28) = 3.5$, $p = 0.003$, $\eta 2 = 0.60$. This significant omnibus *F*-statistic was due to the professional musicians having significantly smaller color-word interference effects, faster P3b latencies at Pz, more frequent peak experiences during waking, eyes-closed and sleep, higher scores on the Gibbs' Sociomoral Reflection questionnaire, and a trend for faster P3a latencies at Fz. There were no group differences on the Brain Integration Scale. Table 1 presents the means, standard deviations and statistics for the two groups on all variables.

3.1. Exploratory correlation analysis

A correlation analysis investigated the relation among the 12 variables in the MANOVA plus age. Table 2 presents the result of the correlation analysis. Significant correlations are bolded and have asterisks to indicate significance of the correlation. Age correlated positively with all measures of reaction time—older subjects had slower reaction times and longer latency of brain functioning, probably reflecting age-related slowing. The four measures of the Survey of Peak Experiences correlated positively together. These four questions appear to bring out different dimensions of a single inner experience.

Scores on the Brain Integration Scale positively correlated with frequency of peak experiences ($r = 0.25$) and with scores on the Sociomoral Reflection questionnaire ($r = 0.26$), Also, faster resolution of response conflict during the Stroop test correlated with higher scores on the Sociomoral Reflection questionnaire ($r = -0.26$).

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Table 1
Means, standard deviations and statistics for the professional and amateur musicians on all variables. Significant differences are bolded for easy identification.

	Professional	Amateur	$F(1, 49)$	p-value	$\eta 2$
Word reaction time (s)	24.7 (5.3)	23.8 (2.8)	<1.0	ns	0.01
Color-word interference effects (s)	**7.9 (6.6)**	**12.5 (7.4)**	**12.2**	**0.001**	**0.20**
P3a latency at Fz (ms)	317.3 (42.7)	342.8 (55.9)	3.3	0.076	0.06
P3a amplitude at Fz (μV)	4.3 (3.1)	3.1 (2.5)	1.8	0.19	0.04
P3b latency at Pz (ms)	**369.9 (53.4)**	**427.1 (84.1)**	**8.2**	**0.006**	**0.15**
P3b amplitude at Pz (μV)	5.0 (3.8)	4.9 (2.9)	<1.0	ns	0.01
Peak Experiences: waking	**6.1 (1.8)**	**3.6 (2.8)**	**13.9**	**0.001**	**0.23**
Luck	3.8 (2.2)	3.1 (2.3)	1.2	ns	0.03
Peak Experiences: eyes-closed	**5.0 (2.2)**	**2.4 (2.7)**	**14.8**	**0.000**	**0.24**
Peak Experiences: sleep	**2.5 (2.2)**	**0.9 (1.6)**	**6.1**	**0.018**	**0.12**
Social Reflection questionnaire	**3.43 (.16)**	**3.32 (.13)**	**7.2**	**0.010**	**0.13**
Brain Integration Scale (z-scores)	2.48 (1.22)	2.45 (1.21)	.028	ns	0.001

Note: significant differences are bolded for ready identification. The professional musicians had smaller color-word interference effects, faster P3b latency, more frequent peak experiences during waking, eyes-closed and sleep, and higher scores on the Gibbs' Social Reflection questionnaire.

Table 2
Correlation table presenting Pearson correlation coefficients between age and the 10 variables that distinguished groups. Significant correlations are bolded and have asterisks to indicate level of significance.

Variables	Age	RT: word	RT interference	Gibbs	P3a latency	P3b latency	Peak Exp.: waking	Luck	Peak Exp.: eyes-closed	Peak Exp.: sleep
Age	1									
Reaction time: words	**.49****	1								
Reaction time: color-word interference	.05	−.10	1							
Gibbs	.15	.28	**−.26**+	1						
P3a latency	**.64****	**.48****	.10	−.08	1					
P3b latency	**.39***	.20	.21	−.10	.18	1				
Peak Experience: waking	.09	.07	.02	.17	−.12	−.01	1			
Luck	.04	.01	.21	−.05	−.21	−.02	.21	1		
Peak Experience: eyes-closed	.03	.09	.14	.11	−.09	−.12	**.55****	**.39****	1	
Peak Experience: sleep	−.02	−.06	−.12	.14	−.17	−.10	**.33***	**.35***	**.43****	1
Brain Integration Scale	.09	−.04	.14	**.26**+	−.14	−.07	**.25**+	.08	.01	.03

* Correlation is significant at the 0.01 level.
** Correlation is significant at the 0.005 level.
\+ Correlation is significant at the 0.05 level.

4. Discussion

The data partially supported the hypotheses. Group differences were seen in all variables in the predicted direction, except for incidences of luck, a sub-scale of the Survey of Peak Experiences, and scores on the Brain Integration Scale. The professional musicians more quickly processed rare, expected stimuli (P3b), and rare unexpected stimuli (P3a). Enhanced auditory processing in the musicians tested in this study replicates the general finding that professional musicians excel in the ability to pickup and process stimuli in the midst of a complex auditory background. Enhanced auditory processing in the subjects in this study suggests that they are comparable to the general population of musicians studied in other research.

4.1. Color-word interference effects and scores on the Sociomoral Reflection Questionnaire

The professional musicians had significantly smaller color-word interference effects in the Stroop task, which indicates faster resolution of response conflict. To our knowledge, this is a new finding with musicians. In addition, the scores on the Sociomoral Reflection Questionnaire were higher in the professional musicians.

The Stroop task and moral decisions both activate frontal executive circuits. In the Stroop task, incongruent font-color and reading words activate conflicting responses that engages the anterior cingulate gyrus to detect the conflict and the dorsolateral prefrontal cortex to resolve the conflict (Carter & van Veen, 2007). Moral decision making activates two different brain systems: a "reflexive" system involving the limbic cortex governing emotions, and a "reflective" system involving frontal cortices governing executive functioning (Salvador & Folger, 2009). The "reflexive" system is a fast, unconscious, automatic response to incoming sensory experience; the "reflective" system is a slow, conscious, controlled evaluation of the situation. The Sociomoral Reflection questionnaire appears to primarily activate the reflective system, involving frontal cortices. The

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person reads a hypothetical situation such as, "How important is it to save the life of a friend?" and reflects on why they think it might be important or not. The common source in frontal functioning of these two measures is supported by a nagative correlation of higher scores on the Sociomoral Reflection questionnaire with faster speed of resolution of response competition on the Stroop test.

4.2. Frequency of Peak Experiences

The professional musicians had significantly more frequent peak experiences during eyes-closed rest, eyes-open tasks, and during sleep – in fact, all the 25 professional musicians reported such experiences in contrast to only 21 amateur musicians. Maslow observed that classical music readily triggers peak experiences (Maslow, 1971), and asserted that peak experiences could provide the norm for empirical esthetics, citing the ability of great art to evoke peak experiences (Panzarella, 1980). The professional musicians may have peak experiences more readily while playing music and so may be more motivated to continue in that profession. Or, it could be that the many more hours of practicing and performing classical music by the professional musicians could have resulted in their observed higher frequency of peak experiences. The relation of peak experiences and playing music was supported by the musicians' descriptions of their peak experiences on the Survey of Peak Experience form. The vast majority reported that peak experiences occurred during performance (22 out of 25 professional musicians). These descriptions give a picture of an expanded experience that is different from normal waking experiences, and are in line with those reported in the literature (Maslow, 1968; Maslow, 1971; Panzarella, 1980):

> "*This state can occur when I play a concert. In my case it can be described as if my inner expands to include the activity of the whole orchestra and even the audience*". Fifty-two year old female, viola soloist in Oslo Philharmonic Orchestra

> "*It is difficult to describe, but it is feels like experiencing a kind of eternity, contrary to everyday life, which is in continuous movement*". Forty-two year old male, piano soloist in Oslo Philharmonic Orchestra

Peak Experiences were also reported by the amateur musicians. However, only 11 amateur musicians reported peak experiences while playing music. The others reported peak experiences while exercising (5), listening to music (3), while preparing food (1), while reading (1) or not at all (4).

Professional and amateur musicians did not differ in instances of luck. Previous research also reports no difference in instances of luck in world-class compared to average-performing athletes (Harung et al., 2011), but higher instances of luck in top-level managers than in controls (Travis et al., in review). Both sports and classical interpretive performance involve extensive practice of a set routine; the performance has well-defined objectives in a controlled environment. In contrast, business occurs within an ill-defined socio-economic, technological, competitive, and governmental environment that is characterized by high complexity, constant change, and globalization. Therefore, to succeed managers may need to rely more on intuition or hunches in making decisions, and to profit from good luck (Mintzberg, 2007).

4.3. Scores on the Brain Integration Scale

The professional and amateur musicians had similar scores on the Brain Integration Scale. This null finding could be important, and is considered in light of findings from other studies using this measure.

The professional musicians had scores on the Brain Integration Scale (BIS = 2.48) similar to those of world-class athletes (BIS = 2.5) and top-level managers (BIS = 2.48). The world-class athletes placed for three consecutive seasons in Olympic Games, and World Championships, demonstrating their high level of achievement in sports. The top-level managers had held their positions for an average of 18 years and had expanded their companies by many orders of magnitude or successfully turned around failing companies, demonstrating their high level of achievement in management. The professional musicians had reached the top of musical performance internationally, demonstrating high levels of achievement in their field.

The anomaly is between the control groups. The control athletes and the control managers had significantly lower scores on the Brain Integration Scale (BIS = 1.3 and BIS = 1.54, respectively), then the high functioning groups. In contrast, the amateur musicians had higher scores than the athlete and manager control groups, and a similar score (2.45) as the professional musicians.

This finding could suggest that the scores on the Brain Integration Scale represent one's performance potential—a substrate that may support development of domain-specific skills. While Brain Integration Scale scores were similar in both groups, the many more hours of practice by the professional musicians could have resulted in domain-specific improvements such as faster ERP latency and improved performance on the Stroop task compared to the amateurs. More frequent peak experiences in the professional musicians could have resulted from their more extensive schedule of performance, since 22 out of 25 professional musicians commented that peak experiences occurred while playing music.

Similar scores on the Brain Integration Scale in both groups, may reflect the fact that both groups of musicians had played their instrument since childhood, which is reported to enhance visual-spatial, verbal, and mathematical performance in adults (Hyde et al., 2009; Schlaug et al., 2005; Swanwick, 1988). Extensive musical experience during childhood, a time of massive cortical reorganization (Toga et al., 2006), shapes brain connections that continue into adulthood. Similar scores in both groups could also reflect the fact that both were highly educated and had professional positions. The amateur musicians were effective in both their vocation (professional job) and avocation (music).

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This null finding on Brain Integration Scale scores gives rise to two research questions. The first is: What interventions increase scores on the Brain Integration Scale? Many musicians in the improvisational genre such as Alice Coltrane, John Coltrane, Herbie Hancock, Paul Horn, Charles Lloyd, and Paul McCartney reported that they delved seriously into meditation practices to develop their inner Self to support their outer performance (Sarath, 2010). Meditation practice (Transcendental Meditation) is reported to lead to increased scores on the Brain Integration Scale (Travis et al., 2009). Future research could compare changes in scores on the Brain Integration Scale and changes in mastery of a skill or profession with the addition of specific interventions or experiences. Future research could also compare effects of interpretive versus improvisational music on brain structure and functioning. Jazz improvisation, in comparison to interpretive music, is reported to deactivate the parts of the brain involved in cognitive control—the dorsolateral prefrontal and lateral orbital—and activate of the parts of the brain connected with emotional input—the medial prefrontal cortices (Limb & Braun, 2008). The second research question is: Do groups with different scores on the Brain Integration Scale develop domain-specific skills at different rates? The results of this research could help guide curriculum design to develop excellence in the arts, sports, commerce and sciences.

5. Conclusion

These data support the usefulness of considering general processing capabilities, such as level of mind-brain development, in understanding effectiveness in different domains. In these data, playing classical music seemed to foster higher levels of mind-brain development. Future research could investigate different activities, including mental techniques that may enhance mind-brain development. Once identified, these activities could be added to training programs in sports, business, and the arts to support the continued quest for excellence.

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