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Associations Between Music Training and Cognitive Abilities: The Special Case of Professional Musicians

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Abstract

We sought to clarify the commonly accepted link between music training and cognitive ability. Professional musicians, non-professionals with music training, and musically untrained individuals ($N = 642$) completed measures of musical ability, personality, and general cognitive ability. Professional musicians scored highest on objective and self-report measures of musical ability. On personality measures, professional musicians and musically trained participants scored similarly but higher than untrained participants on agreeableness, openness-to-experience, and the personality metatrait *stability*. The professionals scored higher than the other two groups on extraversion and the metatrait *engagement*. On cognitive ability, however, they were indistinguishable from untrained participants. Instead, musically trained non-professionals exhibited the highest cognitive ability. In short, professional musicians differed from other individuals in musical ability and personality, but not in cognitive ability. We conclude that music training predicts higher cognitive ability only among individuals who do not become professional musicians, and offer possible explanations.

Keywords: music, training, cognition, personality, learning

Associations Between Music Training and Cognitive Abilities: The Special Case of Professional Musicians

Over the past few decades, a growing number of studies have tried to elucidate whether music training improves nonmusical cognitive abilities. Although music training has positive associations with general, visuospatial, and language abilities (see Swaminathan & Schellenberg, 2019 for a review), most of the relevant evidence comes from correlational designs (Schellenberg, 2020), which preclude inferences of causation. The issue is further complicated because music training is associated with demographic, personality, and cognitive variables during childhood, when training typically occurs, as well as in adulthood after training has stopped (Corrigall et al., 2013). Moreover, evidence from twin studies documents a genetic component to musical achievement (Hambrick & Tucker-Drob, 2015), musical ability (Mosing et al., 2014), choice of musical instrument and genre (Mosing & Ullén, 2018), practicing music (Hambrick & Tucker-Drob, 2015; Mosing et al., 2014), and the link between musical ability and general cognitive ability (Mosing et al., 2016). These pre-existing and extraneous individual differences in musical and nonmusical variables ensure that musically trained individuals are a poor model for the study of transfer or plasticity, despite claims to the contrary (e.g., Steele & Zatorre, 2018).

In the present investigation, our primary focus was on individuals with the highest levels of musical experience—professional musicians. The available literature typically fails to distinguish professional musicians, whose daily behaviors revolve around music, from musically trained individuals who ultimately become construction workers, chefs, doctors, and so on. Here we defined (1) professional musicians as those whose careers involve music instruction (e.g., music professors) or performance (e.g., members of orchestras), or full-time study at the tertiary level or higher, and (2) musically trained individuals as those who had at least 6 years of lessons and were not working as musicians.

Although the “6-year rule” represents a general consensus in the literature as a threshold for musical expertise (Zhang et al., 2020), it typically ignores whether individuals are working as musicians. This issue is particularly important because of findings showing that music training, when treated as a continuous variable (i.e., duration of formal lessons), has a positive linear association with general cognitive ability in childhood *and* in adulthood (e.g., Corrigall et al., 2013; Degé et al., 2011; Swaminathan et al., 2017). One might logically predict, therefore, that individuals with the highest levels of experience—professional musicians—tend to be intellectually gifted, which seems unlikely. The primary goal of the present investigation was to test our hypotheses that professional musicians are different from musically trained individuals in musical ability and personality traits, but not in cognitive abilities.

Whereas the hypothesis about musical ability is self-explanatory, the hypothesis about cognitive abilities stemmed from evidence that associations between music training and cognitive ability tend to be strongest among middle-class children, very few of whom become professional musicians. For example, 9- to 12-year-olds with at least 2 years of music lessons can have IQs that are 10 points (2/3 of 1 *SD*) higher than their counterparts with no lessons (Schellenberg, 2011). At 7 and 8 years of age, children with 1 year of lessons sometimes exceed their untrained counterparts by 15 points (1 *SD*; Schellenberg & Mankarious, 2012). Associations of such large magnitude preclude a causal role for the training, and suggest instead that high-functioning children are more likely than other children to take music lessons. In any event, preliminary evidence indicates that the link between music training and cognitive ability breaks down when actual musicians are studied. For example, when German university students from nonmusical disciplines (law, physics, psychology) were compared to young adults who played in a symphony orchestra or studied music at the post-graduate level, the musicians had *lower* IQ scores (Brandler & Rammsayer, 2003). In another instance, general cognitive ability did not differ between German university music students and students from other disciplines matched for age and education (Helmbold et al., 2005).

Our hypothesis about personality traits was motivated by evidence that personality predicts occupational choices (Holland, 1997). One personality trait from the Big Five model, openness-to-experience (hereafter *openness*), is associated positively with creativity across domains (Feist, 1998, 2019). Openness also predicts musical behaviors and skills (e.g., Corrigall et al., 2013; Lima et al., 2020), and lifetime amount of music practice (Butkovic et al., 2015). Extraversion is another personality trait that predicts creativity, but not as strongly as openness (Feist, 2019). Because the Big Five traits are intercorrelated, metatraits (higher-order personality factors) have been proposed (DeYoung, 2006). Shared variance between openness and extraversion forms one metatrait that indexes behavioral *engagement*,[1] linked theoretically to the neurotransmitter dopamine (DeYoung, 2013); shared variance among agreeableness, conscientiousness, and neuroticism forms a second metatrait indexing *stability*, linked to serotonin (Hirsh et al., 2009). Because engagement is an aggregate of extraversion *and* openness, it has a strong positive association with creativity (Feist, 2019), which extends to objectively measured creative achievements and everyday creative behaviors, including music (Sylvia et al., 2009).

In a previous study, Kuckelkorn et al. (2021) compared the personalities of professional musicians to those of amateur musicians and nonmusicians. Professional musicians had higher

[1] We avoid standard terminology (*plasticity*) because of potential confusion with neural and behavioral changes that occur as a consequence of experience.

levels of openness than amateurs, who had higher levels than nonmusicians, as one might expect, although neuroticism unexpectedly showed the same pattern. The other main finding was that, in both musician groups, singers were more extraverted than instrumentalists, except for percussionists. One problematic aspect of this study was that amateur musicians were classified as individuals who had played a musical instrument (including voice) at *any* point in their lives for *any* amount of time but were not professionally active. In other words, professional and amateur musicians differed markedly in music training as well as professional status, which makes these response patterns difficult to interpret.

In the present study, we examined group differences in musical ability, personality, and general cognitive ability in a sample that comprised professional musicians and participants who were musically trained or untrained. We expected to find robust group differences in measures of musical ability (professionals > trained > untrained). For personality, previous findings allowed us to be relatively confident that the professional and trained groups would score higher than the untrained group on openness and extraversion, and on engagement more generally. We also expected that professional musicians would have particularly high scores on these personality variables. Finally, although musically trained participants should perform better than untrained participants on a measure of general cognitive ability, we did not expect the professionals to outperform the trained group.

Method

Participants

The study was approved by the local ethics committee at Iscte-University Institute of Lisbon (reference 07/2021). All participants provided informed consent. The sample comprised 642 volunteer participants, who ranged in age from 18 to 84 years (*M* = 34.8, *SD* = 15.1; 384

women, 258 men). They were recruited primarily through social-media postings for an online study on personality and musical abilities, which was open to individuals with any level of musical expertise. To increase the study's appeal, the posting specified that participants would receive feedback about their musical ability and personality. Two of the authors (M.V., P.V.), who are professional musicians, contacted other musicians directly, primarily through social media, asking them to participate and to inform other musicians about the study. The study was made available in four languages (Italian: n = 290, European Portuguese: n = 151, Brazilian Portuguese: n = 150, and English: n = 51), which reflected the make-up of the research team while maximizing sample size and diversity.

The sample was restricted to respondents who fell into one of three groups: professional musicians, musically trained participants who were not professionals, and musically untrained participants. Professional musicians (n = 176) had a music-related job and/or were enrolled as students in a university-level music program. Trained participants (n = 121) had at least 6 years of music lessons but did not meet the criteria for professionals. Thus, this group included many amateur musicians. Finally, untrained participants (n = 345) had a maximum of 2 years of music training. An additional 118 participants with 3-5 years of music lessons were tested but excluded because they could not be identified clearly as trained or untrained. Five other participants were tested but excluded from analyses because of self-reported poor hearing ability (n = 1) or unspecified gender (n = 4).

Professional musicians were employed as music professors (n = 126), orchestral musicians (n = 41), soloists (n = 50), conductors (n = 12), choristers (n = 8), pianists (n = 26), composers (n = 25), and members of small musical ensembles (n = 67), but these categories were not mutually exclusive. The most common primary instrument was piano/keyboard, both for professional musicians (44%) and trained participants (40%). Table 1 provides details separately for professional musicians and trained participants, using standard instrument categories (voice, woodwind, etc.). When asked about the genre of music they performed (or had performed) most regularly, a majority played classical music in both groups (professionals: 88.9%; trained: 74.8%). The next most common genre was pop music (professionals: 3.7%; trained: 12.2%). Some trained participants played rock music (7.8%) and some professionals played jazz (3.1%), but all other genres were played by less than 2% of participants in either group.

The online testing format and the exploratory nature of the research motivated us to test as many participants as possible. A post-hoc sensitivity analysis conducted with G* Power 3.1 (Faul et al., 2007) confirmed that a sample of 642 participants had 80% power to detect small associations of at least $.01 \leq \eta^2 \leq .02$ (Analysis of Covariance, three covariates, alpha = .05).

Materials and Tasks

All tasks and questionnaires were adapted for Gorilla Experiment Builder (Anwyl-Irvine et al., 2018), a widely used and flexible platform for online behavioral research. Each measure in the testing protocol was created originally in English. Whenever available, published translations were used for the European Portuguese, Brazilian Portuguese, and Italian versions of the tests. Otherwise, *ad hoc* translations were created by native speakers who were also fluent in English. Correia et al. (2021) documented that the online versions and translations of all tests used in the present study had good reliability and validity, matching that of in-person testing conducted in English (Swaminathan et al., 2021), and that performance did not vary as a function of testing language.

Questionnaires

Goldsmiths Musical Sophistication Index (Gold-MSI). The Gold-MSI (Müllensiefen et al., 2014; Lima et al., 2020) is a 38-item self-report questionnaire evaluating different aspects of musical behaviors and abilities. Responses to each item are made on 7-point rating scales. Scores on different subsets of items are averaged to form five subscales: Active Engagement (e.g., *I often read or search the internet for things related to music*), Perceptual Abilities (e.g., *I am able to judge whether someone is a good singer or n*ot), Music Training (e.g., *I would not consider myself a musician*), Singing Abilities (e.g., *If somebody starts singing a song I don't know, I can usually join in*), and Emotions (e.g., *I sometimes choose music that can trigger shivers down my spine*). A General Musical Sophistication factor is also formed, averaged from 18 items representative of the five subscales. The Music Training subscale is notable for considering—in addition to lifetime duration of music lessons and regular practice—music theory, number of musical instruments, peak amount of practice, perceived status as a musician, and compliments on performances. Our principal interest was in the subscales that measured music training and musical abilities (i.e., Music Training, Perceptual Ability, Singing Ability).

Big-Five Inventory (BFI). The BFI (John & Srivastava, 1999) is a widely used self-report questionnaire that includes 44 items, which measure the traits from the five-factor model of personality (McCrae & John, 1992): Openness-to-Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. Participants rate how well each item describes them on a 5-point rating scale. The five personality traits are calculated as mean scores. Metatrait scores are derived by using principal-components analysis to extract the shared variance between openness and extraversion scores to form engagement scores, and the shared variance among agreeableness, conscientiousness, and neuroticism scores to form stability scores.

Mind-Wandering Questionnaire (MWQ). The MWQ (Mrazek et al., 2013) is a 5-item questionnaire measuring trait levels of mind-wandering (e.g., *I find myself listening with one ear, thinking about something else at the same time*). Participants rate their agreement with each item on a 6-point rating scale (1 = *almost never*, 6 = *almost always*). The mean serves as an index of an individual's frequency of mind-wandering.

Objective Ability Tests

Musical Ear Test (MET). The MET (Wallentin et al., 2010) is an objective measure of musical ability that has two subtests, Melody and Rhythm, presented in that order. On each of 52 trials per subtest, participants hear two short sequences of piano tones (Melody) or drumbeats (Rhythm) and judge whether they are identical. Half of the trials are *different*, such that one or more tones are displaced in the Melody subtest, and one or more inter-onset intervals are altered in the Rhythm subtest. Detailed information about the MET stimuli is provided in Swaminathan et al. (2021). Scores for both subtests are calculated as the number of correct responses.

Because the MET was administered at the end of the testing session and was relatively lengthy (approximately 20 min), some participants did not finish the test or provided incomplete data. MET Melody or Rhythm scores were also excluded for participants with more than 10 (of 52) or 5 consecutive missing responses on a subtest. Sample sizes were therefore smaller when analyses included the Melody (n = 546) or the Rhythm (n = 529) subtest.

General Cognitive Ability. General cognitive ability (hereafter cognitive ability) was tested with the Matrix Reasoning Item Bank (MaRs-IB; Chierchia et al., 2019). The MaRs-IB, which has been used successfully by a variety of independent research groups (e.g., Correia et al., 2021; Nussenbaum et al., 2020), is a freely available online measure of abstract (nonverbal) reasoning modeled after Raven's Advanced Progressive Matrices (Raven, 1965). The test has 80 trials. On each trial, a 3 x 3 matrix is presented. Eight of nine cells contain abstract shapes (varying on four dimensions: color, size, shape, and location), but the cell in the bottom-right corner is always empty. Participants' task is to choose one of four alternatives to complete the matrix, following the rules that govern differences among the other eight cells. The duration of the task is fixed at 8 min, but participants are not informed of the duration or the number of trials, only that they have up to 30 s to complete each trial. If participants complete the 80 trials in less than 8 min, the trials begin again in the same order, but responses from the second round are not considered in calculating scores, which are the proportion of responses given by the participant that are correct (excluding responses made in < 250 ms). Proportions were logit-transformed for statistical analyses.

Procedure

After providing informed consent, participants completed the questionnaires in the following order: MWQ, Gold-MSI, and BFI. After the questionnaires, they completed the MaRs-IB followed by the MET. At the end of the testing session, participants were provided with summary feedback about their personality, musical sophistication, and musical abilities. Ethical considerations precluded feedback about cognitive ability.

Results

We initially compared our three groups of participants in terms of basic demographic variables. Descriptive and inferential statistics are provided in Table 2. Analysis of Variance (ANOVA) uncovered group differences in both age and education. Follow-up pairwise comparisons (Tukey's HSD) revealed that professional musicians were older than trained and untrained participants, ps $< .001$, who did not differ, $p = .979$. Professional musicians also had more education than trained participants, $p = .032$, and untrained ones, $p < .001$, who did not differ, $p = .079$. A chi-square test of independence indicated that the gender ratio also differed across groups, with a greater proportion of males among professional musicians than among trained participants, $p < .001$, and untrained ones, $p < .001$, who did not differ, $p = .726$. Thus, age, education, and gender were included as covariates in the statistical analyses that follow. As one would expect from the available literature (Deary et al., 2007; Hartshorne & Germine, 2015; Salthouse, 2009), cognitive ability also had a small negative correlation with age, $r = -.089$, $N = 642$, $p = .023$, a positive correlation with education, $r = .190$, $N = 642$, $p < .001$, but no association with gender, $p = .165$.

Analysis of Covariance (ANCOVA) confirmed that our three groups of participants differed on each of the music variables. Descriptive and inferential statistics are provided in Table 3 and illustrated in Figure 1, with variables standardized for comparability. Follow-up comparisons (Tukey's HSD) revealed that professional musicians scored higher than musically trained participants, who scored higher than the untrained group, on the MET Melody subtest, and on the Music Training, Perceptual Abilities, and Singing Abilities subscales from the Gold-MSI, *p*s < .005. This same pattern (i.e., professionals > trained > untrained) extended to the Active Engagement subscale and the General Factor from the Gold-MSI, *p*s < .001. The professional and trained groups scored higher than untrained participants on the MET Rhythm subtest and on the Emotions subscale from the Gold-MSI, *p*s < .001, but the professional and trained groups did not differ (Rhythm: $p = .936$, Emotions, $p = .221$). In short, expected group differences in musical ability were strong, whether performance was indexed objectively or by self-reports.

Descriptive and inferential statistics for personality variables are provided in Table 4 and illustrated in Figure 1. For the Big Five traits, the three groups did not differ in terms of neuroticism, but they did on the other four traits. As expected, professional musicians and trained participants had higher mean openness scores compared to untrained participants, *p*s $< .001$, but the professional and trained groups did not differ, $p = .132$. Agreeableness showed a similar pattern, with professionals, $p = .003$, and trained participants, $p = .013$, scoring higher than nonmusicians, but no differences between the professional and trained groups, $p = .984$. Professional musicians had higher conscientiousness scores than untrained participants, $p = .013$, but the trained participants fell in between, such that they were no different from the professional, $p = .604$, or untrained, $p = .296$, groups. Finally, professional musicians were more extraverted than trained participants, $p = .001$, and untrained participants, $p = .006$, but the trained and untrained groups did not differ, $p = .413$.

Because Kuckelhorn et al. (2021) reported that extraversion was elevated only for vocalists, we compared professional musicians and trained participants who were vocalists to other participants from these two groups. Mean levels of extraversion were slightly *lower* ($M = 3.26$) for vocalists compared to other participants ($M = 3.28$). We also compared vocalists *and* percussionists, who did not differ in Kuckelhorn et al.'s study, to other participants from the professional and trained groups. Again, mean levels of extraversion were slightly lower for the vocalists and percussionists ($M = 3.20$ vs. $M = 3.29$). Higher extraversion scores for the professionals over the trained participants also remained evident when instrument category was held constant, $F(1, 275) = 14.69$, $p < .001$, partial $\eta^2 = .051$, and there was no main effect of instrument category, $p = .469$, and no interaction between instrument category and the two groups, $p = .919$. Finally, we conducted the same statistical analyses reported by Kuckelkorn et al. and failed to replicate their results: For professional musicians, there was no effect of main-instrument category on Big Five personality traits in a Multivariate Analysis of Variance

(MANOVA), *p* = .314, or on extraversion in a univariate ANOVA, *p* = .397; for musically trained participants, findings were similar (MANOVA: *p* = .188, ANOVA: *p* = .892).

For personality metatraits (Table 4, Figure 1), engagement scores were higher for professional musicians compared to trained participants, *p* = .001, and untrained ones, *p* < .001, and higher for trained than for untrained participants, *p* = .019. Stability scores were higher for professional musicians, *p* = .004, and trained participants, *p* = .021, compared to untrained participants, but the professional and trained groups did not differ, *p* = .972.

For cognitive variables, descriptive statistics and inferential statistics are provided in Table 5 and illustrated in Figure 1. The three groups did not differ in mind-wandering, but they did in general cognitive ability. As predicted, trained participants had higher scores than untrained participants, *p* = .048. Unexpectedly, trained participants also had higher scores than professional musicians, *p* = .035, who did not differ from untrained participants, *p* = .864. After adjusting for the covariates, professionals actually had the *lowest* mean. Because the professionals were older on average than the other groups, if their absolute (unadjusted) levels of performance matched that of the trained participants, this could potentially indicate higher-than-expected cognitive ability. Nevertheless, even when age was allowed to co-vary, the advantage remained evident for trained participants over professional musicians, *p* = .005, and untrained participants, *p* = .038, but the professional and untrained groups did not differ, *p* = .427.

We also considered whether the method of scoring the MaRs-IB played a role in response patterns, because it awarded the same score for (1) participants who took the maximum amount of time (30 s) for each item and were correct on 14 of 16 trials, and (2) those who completed 48 trials with 42 correct responses (i.e., proportion correct = .875 in both instances). Accordingly, we re-calculated our measure of cognitive ability as the *sum* of correct responses, which is consistent with scoring of Raven's test, whether timed (Swaminathan et al., 2017) or untimed (Carpenter et al., 1990). Response patterns did not change. There was a main effect of group, with trained participants scoring higher than untrained participants, $p = .012$, and professional musicians, $p = .003$, who did not differ, $p = .607$. In absolute terms, mean scores (adjusted and unadjusted) were lowest for the professionals.

Discussion

We examined how professional musicians and musically trained and untrained individuals differ in terms of musical ability, personality, and cognition. Compared to untrained participants, the musically trained and professional groups had higher scores on all measures of musical ability, the Big Five traits openness and agreeableness, and both personality metatraits. Being a professional musician was additionally predictive of even higher levels of musical ability, extraversion, and the metatrait engagement.

As expected, the musically trained group performed better than the untrained group on our test of cognitive ability, a finding that replicates previous results (for review see Swaminathan & Schellenberg, 2019). There was no evidence, however, of enhanced cognitive abilities among professional musicians, who scored significantly *lower* than trained participants, and no different from the untrained group. How interpretable is this novel finding? Our large sample size makes it unlikely that statistical power played a role. It seems implausible, moreover, that professionals would *exceed* the trained participants in attempts to replicate our findings directly. This result is inconsistent with proposals that learning and performing music play a causal role in determining nonmusical cognitive abilities (e.g., Patel, 2011; Tierney & Kraus, 2013). Indeed, such hypotheses of far transfer and plasticity remain contentious (e.g., Sala & Gobet, 2020; Degé, 2021). As one example, Jäncke (2009) speculated that "when learning to play a musical instrument, the trainee also practices attention, planning functions, memory, and self-discipline. It is thus hypothesized that musical experience would positively influence executive functions, language functions, or even intelligence in general." If this hypothesis were true, such effects might reach a plateau at some point, but they would be unlikely to go in reverse.

Nevertheless, our test of general cognitive ability was a single, brief test of abstract reasoning, even though general cognitive ability (*g*) is best measured as a latent variable extracted from a battery of tests that cover a wide range of abilities (Carroll, 1993). Clearly, a large battery of tests was unfeasible with our online testing context, such that our choice to administer the MaRs-IB was motivated primarily by practical reasons. As noted, however, the MaRs-IB is modeled after Raven's Advanced Progressive Matrices (Raven, 1965), which measures "the ability to induce abstract relations and the ability to dynamically manage a large set of problem-solving goals in working memory" (Carpenter et al., 1983, p. 404). Such abilities are considered central to virtually all concepts of intelligence, even those that attempt to expand its definition beyond "book smarts" (Sternberg, 1985). Indeed, matrix-reasoning tests are sometimes considered to be the best single-test proxy for *g* (e.g., Deary & Smith, 2004). Even when full-scale IQ is estimated from only two tests, as in the Wechsler Abbreviated Scale of Intelligence (Wechsler, 2011), one is a test of matrix reasoning. In short, although a clear limitation of the present study is that the results (re: cognitive ability) could be test-specific, or specific to tests of matrix reasoning, our choice of test was defensible, perhaps even optimal, in light of the testing context.

Our finding of elevated engagement and extraversion for professional musicians, but not for musically trained participants, seems intuitive because most professional musicians perform music publicly, at least at some point in their lives. Additionally, most of our professionals were music professors in addition to instrumentalists (≈72% in our sample), and education is in essence a social process. Engagement and extraversion have also been associated previously with creative behaviors, including music (Feist, 2019; Sylvia et al., 2009). Our results differ from those of Kuckelkorn et al. (2021), however, who documented high levels of extraversion among some subgroups of professional musicians (vocalists), but not others. In the current study, we found evidence of a more general effect, with group differences in engagement and extraversion being independent of instrument category. Our subgroups of participants per category were small (e.g., 16 professional vocalists), though, because we did not set out to explore instrument effects. Future research could explore the possibility of such effects in greater detail.

Although our results showed that professional musicians differ from other individuals primarily in terms of musical abilities and personality, there is no doubt that some musicians are very intelligent. For example, Miles (1926) used biographical information to estimate Mozart's IQ as between 150 and 155. Brian May, the guitar player for Queen (and composer of *We Will Rock You*), is another example. May earned a PhD in astrophysics, collaborated with NASA, served as chancellor of Liverpool John Moores University, and has an asteroid named after him. IQ is also associated positively with eminence as a musician or composer, as it is across professions, although personality factors are as important as cognitive ability in predicting high levels of achievement (Miles, 1926; Simonton, 2006, 2009). The *average* professional musician, however, appears to differ from the general population primarily in terms of personality and musical ability rather than cognitive ability.

We propose that individual differences in musical ability, personality, and cognitive ability, in combination with contextual factors (e.g., socio-economic status), jointly influence developmental trajectories of musical experience. Crucially, however, they contribute differently in predicting (1) who takes music lessons and for how long, and (2) who becomes a professional musician. During the childhood and teenage years, those who have high levels of musical ability, openness-to-experience, and cognitive ability, would tend to take music lessons for the longest duration (Corrigall et al., 2013; Kragness et al., 2021). Individuals with lower levels on one these dimensions would be more likely to discontinue training or never begin, while those with lower levels on two (or three) dimensions would be even more likely to discontinue, probably at an earlier date. In early adulthood, most high-functioning individuals would opt to enter non-music professions because of personal interests, practical reasons (e.g., obtaining a well-paying job), or because of sub-optimal levels of musical ability and/or personality characteristics. Other individuals, with high levels of musical ability and engagement (openness *and* extraversion), would be the most likely to choose a career in music. In some instances, individuals with high levels of musical ability, cognitive ability, *and* engagement might also pursue music further, or enter nonmusical professions while maintaining their involvement in music. These proposals represent testable hypotheses that could be addressed in future developmental, longitudinal, and correlational studies.

Although our emphasis is on self-selection, which has typically been overlooked (Schellenberg, 2020), the environments people seek out undoubtedly influence who they become (Sauce & Matzel, 2018). In the case of skilled musical performance, the role of practice is incontrovertible. For objective measures of musical ability, however, music training plays a negligible role (Kragness et al, 2021). For cognitive ability and personality, shared environmental effects also appear to be small. Although the environment explains approximately half of the variance, these effects stem primarily from individual (non-shared) experiences (Harris, 2006).

In sum, our findings document important differences between professional musicians and nonprofessional but musically trained individuals. These differences need to be considered carefully when interpreting the results of published research, and when designing future studies.

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Table 1

Primary Instrument Category for Musically Trained Participants and Professional Musicians

	Musically Trained	Professional Musicians
Bowed	8	33
Brass	5	3
Keyboard	49	78
Percussion	2	3
Plucked	14	13
Voice	26	16
Woodwind	11	25
Others	1	2
No Response	5	3
Total	121	176

Table 2

Descriptive and Inferential Statistics for Demographic Variables

	Musically Untrained		Musically Trained		Professional Musicians		Group Comparison	
	M	*SD*	*M*	*SD*	*M*	*SD*	$F(2, 639)$	η^2
Age	32.40	14.85	32.70	14.18	40.94	14.48	21.39	.063
Education	3.98	1.05	4.21	1.04	4.52	0.92	16.24	.048
	M/F	%M	M/F	%M	M/F	%M	$\chi^2(2)$	ϕ
Gender	123/222	35.6	41/80	33.9	94/82	53.4	17.75	.166

Note: All *p*s < .001.

Table 3

Descriptive and Inferential Statistics for the Musical Ear Test (MET) and the Goldsmiths Musical Sophistication Index (Gold-MSI).

	Musically Untrained		Musically Trained		Professional Musicians		Group Comparison		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	d. f.	η^2
MET									
Melody	34.74	6.43	39.99	5.70	43.10	4.71	87.14	540	.241
Rhythm	36.71	5.71	39.46	5.08	40.30	4.46	18.65	523	.065
Gold-MSI									
Active Engagement	3.88	1.23	4.58	0.99	5.25	0.82	97.02	636	.230
Perceptual Abilities	4.94	1.07	6.03	0.69	6.38	0.55	165.58	636	.341
Music Training	2.39	1.19	5.36	0.78	6.05	0.55	923.47	636	.742
Singing Abilities	3.76	1.35	4.97	0.96	5.41	0.89	132.18	636	.292
Emotions	5.49	0.95	6.00	0.67	6.05	0.77	41.66	636	.112
General Factor	3.55	1.12	5.06	0.77	5.73	0.52	352.50	636	.521

Note: All *p*s < .001. Age, education, and gender were held constant in the group comparisons. All *F* statistics have 2 d.f. in the numerator.

Table 4

Descriptive and Inferential Statistics for the Personality Variables

	Musically Untrained		Musically Trained		Professional Musicians		Group Comparison		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2
Big Five									
Openness	3.80	0.59	4.14	0.54	4.31	0.43	42.83	< .001	.118
Conscientiousness	3.50	0.69	3.63	0.68	3.80	0.71	4.23	.015	.012
Extraversion	3.17	0.82	3.07	0.84	3.43	0.68	7.39	< .001	.022
Agreeableness	3.71	0.56	3.87	0.53	3.89	0.54	7.44	< .001	.022
Neuroticism	3.17	0.79	3.04	0.88	2.92	0.89	1.25	.287	.004
Metatraits									
Engagement	-.259	1.01	.023	.968	.492	.789	27.54	< .001	.078
Stability	-.183	.936	.101	.965	.290	1.07	6.83	.001	.019

Note: Age, education, and gender were held constant in the group comparisons. All *F* statistics have 2, 636 d.f.

Table 5

Descriptive and Inferential Statistics for the Cognitive Variables

	Musically Untrained		Musically Trained		Professional Musicians		Group Comparison		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2
Mind Wandering	3.29	0.96	3.13	0.88	2.88	0.95	2.75	.064	.008
Cognitive Ability—1	.614	0.15	.654	0.15	.614	0.14	3.59	.028	.010
Cognitive Ability—2	23.3	5.64	25.1	6.73	22.0	5.31	5.90	.003	.017

Note: Cognitive Ability—1: Proportion of responses that were correct (logit transformed in analysis). Cognitive Ability—2: Sum of correct responses. Age, education, and gender were held constant in the group comparisons. All *F* statistics have 2, 636 d.f.

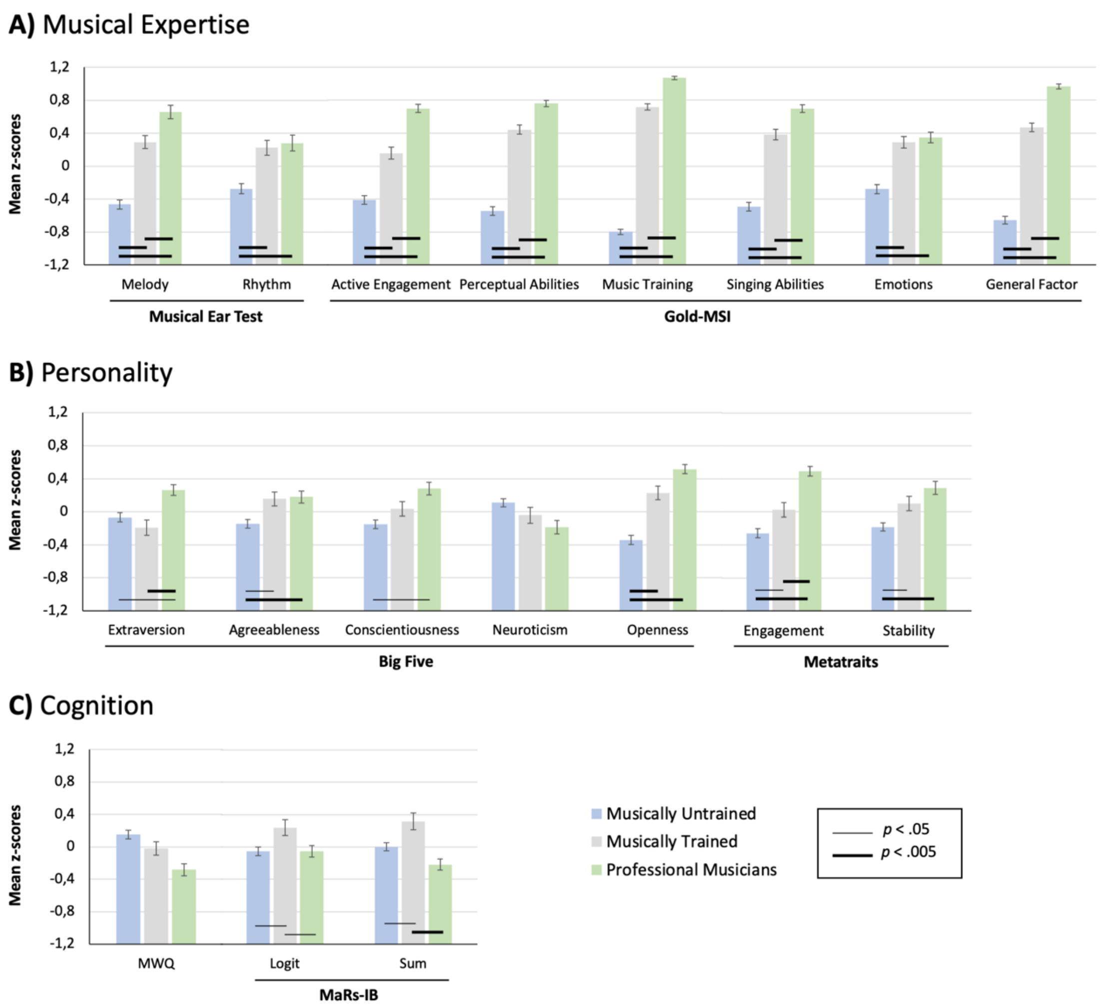

Figure 1. Means and standard errors for study variables, standardized for comparability. Pairwise comparisons (Tukey's HSD) were conducted after ANCOVA confirmed a significant main effect of group (covariates: age, education, and gender).