Openness to Experience and Auditory Discrimination Ability in Music: An Investment Approach

Karen S. Thomas, Paul J. Silvia, Emily C. Nusbaum, Roger E. Beaty, & Donald A. Hodges

University of North Carolina at Greensboro

Author Note

Karen S. Thomas and Donald A. Hodges, School of Music, Theatre and Dance, University of North Carolina at Greensboro; Paul J. Silvia, Emily C. Nusbaum, & Roger E. Beaty, Department of Psychology, University of North Carolina at Greensboro.

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Correspondence can be addressed to either Karen Thomas or Paul Silvia, University of North Carolina at Greensboro, P. O. Box 26170, Greensboro, NC, 27402-6170; klsander@uncg.edu or p_silvia@uncg.edu.

Abstract

Why do people vary in how well they discriminate musical sounds? The present research explored personality traits as predictors of auditory discrimination ability, a cornerstone of many popular musical aptitude tests. According to investment-theory approaches, personality traits can shape the growth of cognitive abilities by affecting the kinds of activities and experience people select. It thus seems likely that Openness to Experience—a broad trait associated with aesthetic and creative interests—would predict variation in auditory abilities because it is associated with greater engagement with music. A sample of 183 young adults completed an auditory discrimination task (the Musical Ear Test), the HEXACO personality inventory, and items measuring past music training. As expected, Openness to Experience significantly predicted auditory ability ($\beta = .28$ [.14, .42]). Mediation models indicated that this effect was fully mediated by music training: people high in Openness had significantly more formal training in music, and music training in turn significantly predicted auditory ability. The findings thus strongly support an investment-theory approach to understanding the role of personality in musical auditory abilities.

Keywords: personality; auditory ability; musical ear test; openness to experience; music expertise; investment theories

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The ability to discriminate between musical auditory stimuli has been widely studied in music education and is the cornerstone of many popular musical aptitude tests, such as Gordon's (1965) *Musical Aptitude Profile* or the *Seashore Measures of Musical Talents* (1939). Music researchers have studied individual differences in auditory ability extensively, and to date, research has emphasized formal training in music as a major source of individual differences in auditory ability. In the present research, we extend this literature by examining personality traits—particularly the trait of Openness to Experience (McCrae & Sutin, 2009)—as a predictor of auditory ability. Investment models of cognitive abilities (von Stumm & Ackerman, 2013) point out that personality traits can affect cognitive abilities by influencing the kinds of experiences and activities people pursue. Because people high in Openness to Experience—a trait associated with creative and artistic interests—are engaged more deeply with music (e.g., Corrigall, Schellenberg, & Misura, 2013; Nusbaum & Silvia, 2011), an investment approach would suggest that they likely have higher auditory ability as a result.

Auditory Discrimination Ability

A wide range of psychological factors influence how people perceive sound (Hodges & Sebald, 2011), and stable individual differences in how well people can distinguish between musical sounds have been studied since the early period of intellectual assessment (Carroll, 1993), usually as part of tests of musical ability. Most musical ability tests take an "atomistic" approach to musicality by measuring musical ability through distinct skills, such as discriminating the difference between two tonal pitches (Ullén, Mosing, Holm, Eriksson, & Madison, 2014). Music aptitude tests measure musical ability and one's potential to achieve in music. They differ from music achievement tests, which measure what someone has learned about music. The earliest standardized measure of music aptitude came from Carl Seashore, whose work influenced the further development of such tests. His tests, the *Seashore Measure of Musical Talent* (1919), later revised and renamed the *Seashore Measures of Musical Talents* (Seashore et al., 1939), were based on psychological aspects of music, such as pitch, loudness, duration, and timbre (tone quality).

In a typical auditory discrimination test, comparisons of individual sounds, patterns, or short excerpts of music are presented aurally, and then participants choose responses such as *same/different* or *higher/lower*. Edwin Gordon, for example, created tests of varying difficulties suitable for different levels and age groups: (a) *Musical Aptitude Profile* (Gordon, 1965), designed for subjects in fifth through twelfth grade; (b) *Primary Measures of Music Audiation* (Gordon, 1979), designed for subjects in Kindergarten through third grade; (c) *Intermediate Measures of Music Audiation* (Gordon, 1982), designed for subjects in first through sixth grade; (d) *Advanced Measures of Music Audiation* (Gordon, 1989), designed for advanced subjects in seventh grade through adulthood; and (e) *Audie* (Gordon, 1989), designed for children aged three and four. Recent work in music aptitude measurements have produced several tests designed for adults, such as the *Musical Ear Test* (Wallentin, Nielsen, Friis-Olivarius, Vuust, & Vuust, 2010a), the *Profile of Musical Perception Skills* (Law & Zentner, 2012), and the *Swedish Musical Discrimination Test* (Ullén et al., 2014).

Many studies show that auditory abilities can be increased through musical training (e.g., Gromko & Walters, 1999; Jordan-DeCarbo, 1989; Kishon-Rabin, Amir, Vexler, & Zaltz, 2001; Micheyl, Delhommeau, Perrot, & Oxenham, 2006). In a notable study, Holahan, Saunders, and Goldberg (2000) examined differences between college age musicians', college age non-musicians', and first-grade general music students' tonal cognition of auditory pattern discrimination. Tonal tests created by the researchers were administered to the participants, and the results indicated that the college age musicians' scores were significantly higher than both other groups' scores. The average score for the first-grade group, however, was only slightly lower than the non-musician college group. Because the first graders and non-musician college students had similarly low scores, it seems likely that musical training has a much greater effect on auditory ability than maturation or passive musical experiences (e.g., listening to music and attending performances).

Personality and Auditory Ability

An investment-theory approach to cognitive abilities (von Stumm & Ackerman, 2013) would suggest that personality traits are important contributors to the development of abilities such as auditory discrimination. Investment approaches assume that personality traits can cause changes in intelligence by influencing how people invest their time and effort. Intellectual investment traits—"stable individual differences in the tendency to seek out, engage in, enjoy, and continuously pursue opportunities for effortful cognitive activity" (von Stumm, Chamorro-Premuzic, & Ackerman, 2011, p. 225)—influence the growth of cognitive abilities by shaping the kinds of experiences and activities people seek out and pursue. For example, people high in traits like curiosity (Silvia & Kashdan, in press), need for cognition (Cacioppo, Petty, Feinstein, & Jarvis, 1996), and typical intellectual engagement (Goff & Ackerman, 1992) have higher levels of crystallized intelligence because they spend more time and effort in intellectual pursuits, such as reading. An investment approach thus presumes mediation: personality traits prompt people to engage in activities and experiences that, in turn, cultivate knowledge and abilities.

In five-factor models of personality, Openness to Experience is the higher-order trait that encompasses the family of intellectual investment traits reasonably well (Chamorro-Premuzic & Furnham, 2006). A core feature of Openness to Experience is curiosity, a desire to learn new things and try new activities (Silvia & Kashdan, in press). As a result, Openness to Experience is the only personality trait in five-factor models that correlates appreciably with fluid and crystallized intelligence (DeYoung, Quilty, Peterson, & Gray, 2014; Ziegler, Danay, Heene, Asendorpf, & Bühner, 2012). Another core feature of this trait is aesthetic interests: people high in Openness to Experience are much more passionate about the arts (Chamorro-Premuzic, Reimers, Hsu, & Ahmetoglu, 2009) and are more likely to pursue artistic and creative college majors and occupations (Larson, Rottinghaus, & Borgen, 2002; Larson et al., 2010; Silvia & Nusbaum, 2012).

Past work on Openness to Experience and music gives some clues about why it could foster higher auditory ability. First, people high in Openness to Experience are much more engaged with music listening. They more frequently experience aesthetics chills—a pleasurable experience of goose bumps and shivers—while listening to music (Colver & El-Alayli, in press; Nusbaum & Silvia, 2011, 2014), and they experience inner music—imagining music when none is playing in the environment—much more often (Beaty et al., 2013). People high in Openness to Experience also more strongly prefer music genres that are considered reflective, complex, and erudite (e.g., classical and jazz), whereas people low in Openness more strongly prefer conventional, upbeat music (e.g., Top 40 and pop genres; Rentfrow & Gosling, 2003; Rentfrow & McDonald, 2010). Second, Openness to Experience is associated with formal training in music. In one study, young adults high in Openness to Experience were significantly more likely to report that they played an instrument proficiently (Nusbaum & Silvia, 2011). In another, Openness to Experience was significantly associated with how many years people had been playing music regularly (Corrigall et al., 2013), both among children (ages 10 to 12) and young adults. People high in this trait are thus more likely to report such musical training, experiences, preferences that could enhance auditory abilities, but whether they have higher auditory ability levels remains unclear.

The Present Research

The present research explored the relationships between personality and auditory discrimination ability, with an emphasis on Openness to Experience. Our first aim was to determine whether people higher in Openness to Experience have higher levels of auditory discrimination ability, as one would expect in light of research on the family of Openness-related traits as resources for the cultivation of knowledge and abilities (von Stumm & Ackerman, 2013). A sample of participants thus completed a widely-used measure of personality (Lee & Ashton, 2004) along with the Musical Ear Test (MET; Wallentin et al., 2010a), a measure of auditory discrimination ability. Our second aim was to examine whether music training mediates the effect of Openness to Experience on auditory ability. Because people high in this trait are much more likely to play instruments and to have received formal music education, it might affect auditory abilities indirectly. Such an indirect path would be a classic example of an investment effect: because they are more interested in music and the arts, people high in Openness to Experience invest their time and efforts in activities that cultivate the growth of auditory discrimination ability.

Method

Participants

A total of 184 young adults enrolled at the University of North Carolina at Greensboro (UNCG) volunteered to participate. Most of them (n = 174) participated as part of a research option in a psychology course. To expand the variability in musical expertise, we recruited an additional group of music students (n = 10). These participants were currently enrolled in a graduate or undergraduate degree program in music (e.g., music performance, education, theory, or composition) at UNCG, and they received $8 USD in cash as thanks for their participation.

The sample as a whole was primarily female (73%) and young (*M* age = 19.09 years, *SD* = 2.46, *Mdn* = 18.00, *Min*/*Max* = 18, 37). According to self-reported racial and ethnic identification, the sample was 40% African American, 7% Asian American or Pacific Islander, 51% European American, 7% Hispanic or Latino/a, and 3% Native American; the participants could select more than one option or decline to select any.

Procedure

This research project was approved and monitored by the UNCG Institutional Review Board (Study #14-0002). All tasks and surveys were presented and controlled on computers running MediaLab 2012. The study was scheduled in group sessions that ranged from 1 to 8 participants.

The Musical Ear Test (MET). The measurement chosen for the present study, the *Musical Ear Test* (Wallentin et al., 2010a), consists of two sections: melodic and rhythmic discrimination. The test developers indicated that the tests are valid measures of aural discrimination for both musicians and non-musicians. The MET is comprised of short recorded pairs of patterns using piano sounds (melody) or woodblock sounds (rhythm). The melody items contain 3-8 tones, and the rhythm items contain 4-11 beats. Half of the patterns in each section are the same and the other half are different. For the pairs of different patterns, there is one violation in a pattern (e.g., a single pitch or single rhythm is different in one pair). For purposes of time, we used an abbreviated version of the MET by reducing the total number of test items from 104 to 80, with the melody and rhythm subtests divided evenly in both. The abbreviated version had 80 items—40 for melody ($\alpha = .72$), 40 for rhythm ($\alpha = .60$). In each block of 40, half of the items were the same, so chance performance was 50%. The internal consistency of the shorter version was similar to the full-length version, which has a reported Cronbach alpha of .82 for melody and .69 for rhythm (Wallentin et al., 2010b). The participants listened to the sound clips using over-ear headphones, and they could adjust the volume to a comfortable level. For each item, they listened to the sound clip and then made a *same* or *different* judgment by clicking a box with their mouse.

The order of the rhythm and melody sections was counterbalanced across participants and randomly selected by the software. Adapting the test to a computer-based task allowed us to covertly record response times to detect if a participant responded before the item finished playing.

Openness to Experience and personality. To assess personality, we used the 100-item version of the HEXACO (Lee & Ashton, 2004). The HEXACO model of personality (Ashton & Lee, 2007) includes six factors: Honesty-Humility (α = .79), Emotionality (α = .78), eXtraversion (α = .83), Agreeableness (α = .83), Conscientiousness (α = .81), and Openness to Experience (α = .83). For the most part, the HEXACO factors resemble their counterparts in five-factor models of personality. The biggest difference is the distinction between Honesty-Humility and Agreeableness factors in the HEXACO (Lee & Ashton, 2012). The HEXACO-100 provides global factor scores for each trait (measured with 16 items each) as well as four facet scales per factor. The items had a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*).

Musical training. We assessed training and education in music with two items. As in past research (e.g., Krause, North, & Hewitt, 2015), we focused on formal training in music and music performance. First, the participants indicated how many college-level classes in music they had taken. Given the vast range in our sample (0 to 70), the scores were censored at a ceiling of 10 (i.e., all scores 10 or above were set to 10) and the variable was modeled as a censored outcome (Long, 1997). Most of the sample (71%) had taken zero classes; 9% had taken 5 or more. Second, the participants indicated if they played a musical instrument proficiently (scored 0 = *no*, 1 = *yes*); most of the sample (67%) did not play an instrument.

Results

Data Reduction and Screening

One person was dropped because he reported that he responded randomly, thus leaving a final sample of 183 participants. For each person, we computed the average response time to the MET items. Each item's duration was roughly 8 seconds, so MET scores were treated as missing for anyone who had an average response time of 7 seconds or less. HEXACO factor scores were formed by first averaging the scores for each factor's four facets and then averaging across the facets. Unless noted otherwise, all models were estimated in Mplus 7.3 using maximum likelihood with robust standard errors. Confidence intervals (95%) are in square brackets. Table 1 shows the descriptive statistics.

Personality and Auditory Ability

Our first model explored whether the HEXACO personality traits—and Openness to Experience in particular—predicted auditory ability. The MET rhythm and melody subscales were substantially correlated (r = .60), so a MET total score was formed by averaging the subscales. A regression model found that only Openness to Experience significantly predicted MET performance, β = .28 [.14, .42], $p < .001$. No other factor had a significant effect. The standardized effects and their 95% confidence intervals are shown in Table 2.

Music Training as a Mediator

Subsequent models explored if music training mediated the effect of Openness to Experience on auditory discrimination. We combined the two markers of training—number of music classes and whether people played an instrument—using latent variable methods. The two variables served as indicators: the number of classes was specified as censored, and whether people played an instrument was specified as categorical. The resulting latent variable reflects the latent continuous music-training distribution that gives rise to differences in the observed censored and categorical scores (see Long, 1997; Skrondahl & Rabe-Hesketh, 2004).

A regression model with the six HEXACO factors as predictors and the latent musical training variable as the outcome found, as expected, a significant effect of Openness to Experience on training, β = .34 [.20, .49], *p* < .001. A significant effect for Honesty-Humility also appeared, β = .29 [.10, .47], *p* = .002. Table 2 shows the effects for all six factors.

The next analysis explored whether music training predicted auditory ability. Consistent with much past research, music training (modeled as a latent variable, as described earlier) substantially predicted auditory ability. Participants with more music training had significantly higher MET scores, β = .70 [.54, .86], *p* < .001.

Finally, we estimated a mediation model in which we tested whether musical expertise mediated the effect of Openness to Experience on auditory ability. Openness to Experience was the only factor to predict both MET scores and musical training, so the other five HEXACO factors were omitted. Figure 1 illustrates the mediation model and the findings. First, as expected, Openness to Experience significantly predicted music training (β = .37 [.22, .52], *p* < .001), and music training significantly predicted MET performance (β = .68 [.48, .87], *p* < .001). Second, when music training was included as a mediator, Openness to Experience's direct effect on MET performance was smaller and no longer significant (β = .05 [-.12, .22], *p* = .558). As a result, the overall pattern suggests that Openness to Experience predicts MET performance by virtue of its effect on music training.

Mediation was formally evaluated by bias-corrected bootstrapping (MacKinnon, Lockwood, & Williams, 2004), using maximum-likelihood estimation and 1000 bootstrap samples. Bias-corrected bootstrapping adjusts for non-normality in the sampling distribution of the indirect effect, and simulation research shows that it has higher power than other methods (Fritz & MacKinnon, 2007). The analysis found a significant indirect effect, *b* = 1.66, *SE* = .54, *p* = .002, and the bias-corrected confidence intervals excluded zero [.86, 3.12], a finding that further supports a mediation conclusion.

Discussion

What are the sources of individual differences in auditory discrimination ability? The present research brought together two bodies of work: research on how musical training influences auditory discrimination ability (Holahan et al., 2000), and research on how personality traits influence cognitive abilities (von Stumm & Ackerman, 2013). Our study found that people high in Openness to Experience had significantly higher auditory discrimination ability, measured with the MET. Consistent with investment-theory approaches, the effect of Openness to Experience was fully mediated by music training: people high in Openness had higher MET scores because they had higher levels of music education.

The present findings thus offer unusually good support for an investment-theory approach to auditory ability. For the most part, studies of investment theories emphasize components of crystallized intelligence, such as vocabulary, general knowledge, or knowledge in specialized domains (Chamorro-Premuzic & Furnham, 2006; von Stumm & Ackerman, 2013). It is widely known that the broad trait family encompassed by Openness to Experience influences crystallized intelligence, largely because of the curiosity, intellectual interest, and enjoyment of ideas typical of high Openness (Silvia, 2012; Silvia & Kashdan, in press). Because of their heightened interest in music, literature, and the arts, people high in Openness apparently invest their time and effort in activities that ultimately foster higher ability in those areas of interest. It is notable that music training fully mediated the effect of Openness to Experience on auditory discrimination ability: when training was included, the effect of Openness to Experience was non-significant and near zero. This finding suggests that there is no inherent edge associated with Openness to Experience, so people low in this trait are not necessarily at a disadvantage during the course of music education.

The present findings also extend and round out the small body of research on Openness to Experience and music. To date, research has shown that people high in Openness to Experience have notably different music preferences and experiences: they prefer different kinds of music (Rentfrow & Gosling, 2003) and engage more deeply with music, from hearing music in their head more often (Beaty et al., 2013) to more easily getting goose bumps from music (Nusbaum & Silvia, 2011). The present study shows that this greater engagement extends into music-related cognitive abilities. As a result of their greater involvement in music—particularly learning an instrument (Corrigall et al., 2013)—they have developed higher levels of a general cognitive skill in addition to specific music-related knowledge.

A salient limitation of this work is its cross-sectional design. The present findings are consistent with an investment approach, but investment processes are necessarily longitudinal. Future research should examine how personality traits influence auditory discrimination ability using longitudinal designs, which are necessary to establish mediation. A three-time-point design would be ideal for evaluating mediation for longitudinal processes, but several contemporary designs, such as accelerated and half-longitudinal designs (Cole & Maxwell, 2003; Little, 2013), would afford an efficient test of whether personality at early time points influences the growth of auditory ability because of intervening music training.

An interesting question for future work is whether people high in Openness to Experience are aware of their higher ability level. Many studies show that people with higher abilities are less likely to overestimate their skill level and often underestimate it (Zell & Krizan, 2014). Examining self-perceptions of auditory discrimination ability—such as patterns of accuracy and bias in selfappraisals of the ability—would reveal if people high in Openness are aware that their history of music experience and training has given them an edge.

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Table 1

Descriptive Statistics

Variable	*M*	*SD*	*Min, Max*	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. MET Average	26.78	4.02	16.50, 39.00	1										
2. MET Melody	26.15	4.64	14, 40	.90	1									
3. MET Rhythm	27.41	4.24	16, 38	.89	.60	1								
4. Play an Instrument	.33	—	0, 1	.37	.37	.29	1							
5. Number of Music Classes	1.15	2.76	0, 10	.49	.50	.38	.40	1						
6. Honesty-Humility	3.31	.55	1.81, 5.00	.13	.13	.10	.17	.21	1					
7. Emotionality	3.44	.52	2.00, 4.50	-.10	-.05	-.14	-.03	.05	-.01	1				
8. eXtraversion	3.40	.54	1.63, 4.75	.14	.08	.17	.06	-.01	.03	-.10	1			
9. Agreeableness	3.00	.57	1.75, 4.88	.04	.05	.03	-.04	-.08	.24	-.17	.21	1		
10. Conscientiousness	3.42	.51	2.06, 4.75	.12	.12	.10	.10	.14	.32	.04	.21	.07	1	
11. Openness to Experience	3.20	.61	1.63, 4.69	.30	.31	.22	.19	.27	.09	.05	.16	.00	.12	1

Note. *n* = 183. MET Average is the average of the MET Rhythm and Melody subscales. "Play an instrument" is a binary variable and thus lacks a standard deviation; "Number of Music Classes" was censored at 10 (i.e., all values greater than 10 were set at 10). Researchers interested in running their own analyses can obtain the raw data and Mplus input files from the second author.

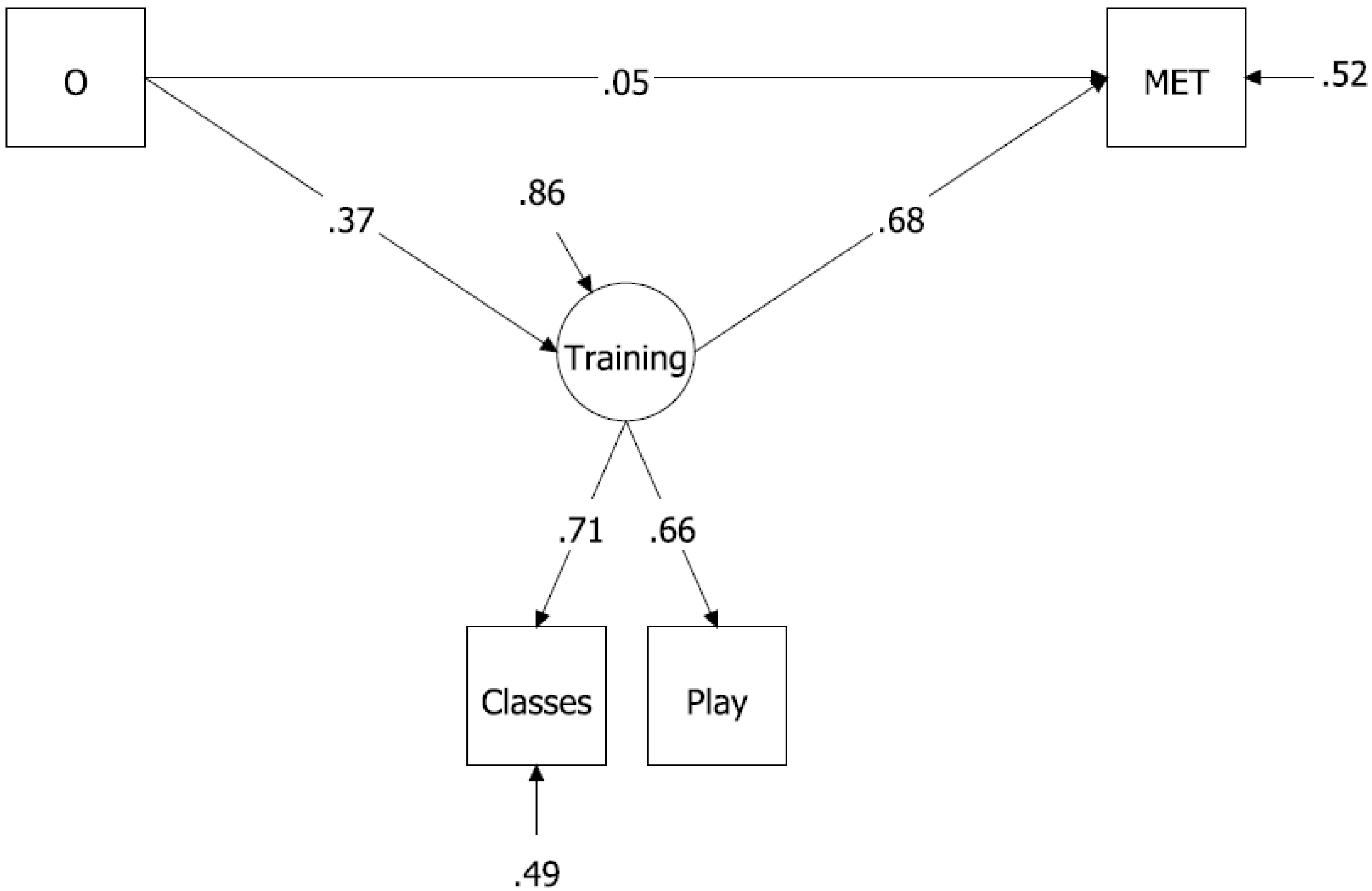
Table 2

Effects of Personality on MET and Music Training

	MET Average		Music Training	
	β [95% CI]	*p*	β [95% CI]	*p*
Honesty-Humility	.09 [-.07, .24]	.279	.29 [.10, .47]	.002
Emotionality	-.11 [-.26, .03]	.112	-.01 [-.19, .17]	.875
eXtraversion	.08 [-.06, .22]	.284	-.03 [-.23, .17]	.755
Agreeableness	-.02 [-.16, .13]	.799	-.18 [-.37, .02]	.071
Conscientiousness	.05 [-.12, .22]	.550	.08 [-.13, .30]	.445
Openness to Experience	.28 [.14, .42]	< .001	.34 [.20, .48]	<.001

Note. n = 183. The coefficients are standardized regression weights.

Figure 1. A mediation model of Openness to Experience, music training, and MET performance.



Note. n = 183. The regression weights are standardized. O = Openness to Experience; Classes = number of music classes taken; Play = whether people play an instrument. Note that "Play," as a categorical outcome, has no residual variance.