Associations between musical preferences and personality in female
secondary school students

Abstract

It is widely believed that someone's personality can be assessed through their musical taste. There are many theoretical approaches that explain why this could be true and a long tradition of research has investigated the associations between personality and musical preferences, but empirical evidence regarding these correlations shows inconsistent results. An explanation for these inconsistent findings could be that personality and musical preferences might be largely stable and not correlated in adults, while during childhood and adolescence these traits may be connected more strongly, since younger individuals' traits are still developing, and music is a highly influential factor at this point of life. Therefore, the aim of the current study is to test whether pupils' personality profiles are associated with musical preferences. Data from a cross-sectional study at a British girl's secondary school was used ($N = 312$) for this purpose. Musical preferences were assessed using a non-verbal inventory with sound examples. Deploying structural equation modelling, regression trees, and random forest models, it was investigated how well ratings of musical sound excerpts can be used to predict the big five personality traits. Results from random forest regression models indicate that extraversion ($R^2 = 6.4\%$), agreeableness ($R^2 = 5.6\%$), and conscientiousness ($R^2 = 4.1\%$) can be predicted by musical preferences to a small degree. In contrast, the explained variance for openness to experience and neuroticism was negligibly small ($<1\%$). The results arising from a data driven structural equation model shows that mellow musical styles are associated with agreeableness, while intense and sophisticated music is correlated with extraversion.

Keywords: Big five, personality, musical preferences, structural equation model, data mining, machine learning

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Wouldn't it be nice if we could tell everything about a person's personality by simply looking at a list of their favourite music pieces? It is possible to imagine that music taste is a mirror of an individual's personality and that people use this heuristic to assess a person's personality by their musical preferences (Schäfer & Melhorn, 2017). In fact, several studies (e.g., Bonneville-Roussy, et al., 2103; Greenberg et al., 2016) have developed and tested appropriate theories to assess this assumption.

One explanation for the assumed relationship between personality and musical preferences is provided by the uses-and-gratifications approach (Katz et al., 1973). It suggests that individuals have personal and social needs which are – at least in part – characterised by their personality traits and that they possess the knowledge of how to satisfy these needs by using media or music (e.g., Delsing et al., 2008). This means that people most frequently chose their preferred music in order to gain gratification from it. Similarly, the theory of optimal arousal (Eyseneck, 1990) describes how people tend to choose their favourite music in order to achieve the amount of arousal that serves their personality best in a given context (e.g., Nater, Krebs, & Ehlert, 2005). The mood management theory by Zillmann (1988) is a related explanation that describes how recipients tend to choose media and music to reach a target mood (e.g., Zillmann, 2000). Most studies on musical preferences and personality use one of these models as theoretical background and research interest in this field has grown in recent years – possibly due to the development of new instruments for measuring musical preferences (Schäfer & Melhorn, 2017). Contemporary research relies on an interactionist approach (Buss, 1987) that explains how individuals intentionally choose and alter their environment so that it fits their needs and these needs are informed by predetermined personality. For example, people use music to satisfy basic psychological needs (e.g.,

Bonneville-Roussy et al., 2013). This theory was supported by many studies showing consistent results across various cultures (Greenberg et al., 2016).

Only recently, a meta-analysis condensed the results of nearly 30 studies that investigated the association between musical taste and personality traits (Schäfer & Mehlhorn, 2017). Their results showed that correlations between dimensions of personality and musical preferences were not consistent across different studies and that even significant correlations mainly indicated small effect sizes ($|r|$ between .10 and .21). Schäfer and Mehlhorn (2017) argue that the relationship between musical preferences and personality is not as strong as generally assumed. Although this conclusion appears to be valid for the studies included in their meta-analysis, the results of this analysis was questioned by Devenport and North (2019). Additionally, it seems questionable if the meta-analytical findings are still true for adolescents since most of the studies in the analysis used adult samples. To our knowledge, so far only two studies investigated the correlation between personality and musical preferences in children or adolescents (Neville, 1985; Ter Bogt, Engels, Bogers, & Kloosterman, 2010), albeit neither of these studies used the big five model (Goldberg, 1990) or the five factor model (Costa & McCrae, 1992) which have become a standard for personality assessment today. Although there is an ongoing discussion about the validity of such a broad personality concept like the big five model (Mischel & Shoda, 1995), we decided to use this model for our purposes and accordingly focus on studies that used the same.

Development of musical preferences and personality

Adults tend to have steady musical tastes that were formed during their lifespan (Behne, 1997; Larson, 1995; Schäfer & Sedlmeier, 2010; for cohort effects and slowly developing age related changes see Bonneville-Roussy et al., 2013). In contrast, the musical taste of children and teenagers is still emerging and preferences are developing at a fast pace during those periods (Hargreaves, 1982; Kopiez & Lehmann, 2008). Research so far indicates that musical

preferences become more stable at the transition from adolescence to adulthood (Bonneville-Roussy et al., 2013). Children and adolescents usually have strong opinions on musical styles (Holbrook & Schindler, 1989) and music plays an essential part in the formation of personal identity during the teenage years (MacDonald, Hargreaves & Miell, 2017). At the same time, adolescents are going through a challenging period and experience substantial changes at the hormonal, cognitive, and social level (Slater & Bremner, 2017), resulting in unstable personality traits (Arnett, 1995). Other recent studies support the assumption that personality is not stable but still developing during this age (Soto & Tackett, 2015). Arguably, during this period of life, adolescents rely highly on their musical tastes and fandom when they struggle with social belonging, decision making, and self-evaluation (Bonneville-Roussy et al., 2013). Musical preferences are likely to develop at this time and contribute to a personal development (MacDonald et al., 2017), although adolescents might sometimes choose to listen to music that does not fit their actual taste or to state divergent preferences if asked which could be due to peer pressure or social assimilation. We argue that both personality traits and musical preferences can change rapidly within individuals over the course of adolescence, but that at the same time traits and preferences change together and are more closely associated than in adults. This is because music plays a larger part in identity formation during adolescence than later in life (Bonneville-Roussy, et al., 2013). Therefore, we expect to find stronger associations of musical preferences with personality in younger people than in adults.

Musical preferences

There are two major approaches for the standardised measurement of musical preferences: 1. Preference or liking ratings in response to verbal genre labels and 2. preference or liking ratings of music excerpts from different genres. For rating genre preferences via verbal labels, Rentfrow and Gosling (2003) provided a now widely used questionnaire and categorization system, the Short Test of Musical Preferences (STOMP). In

a later article, Rentfrow, Goldberg, and Levitin (2011) offered a new approach. In three studies, they used a more comprehensive set of musical styles, each represented by several audio tracks. Analysing preference ratings for these tracks from three different participant samples, they were able to identify five dimensions of musical preferences corresponding to important features of the tracks.

The validity of self-report measurements (e.g. STOMP) has been debated frequently, usually stating that the interpretation of genre labels can be overly subjective. Therefore, Rentfrow and colleagues (2011) proposed preference measurements that avoid verbal labels but use audio stimuli. However, to our knowledge, a non-verbal music preference measurement instrument based on audio files has not been used with adolescents yet.

Personality

The approaches and concepts to measure dimensions of personality are countless, but fortunately, there is now a wide agreement on the big five model of personality which includes the traits openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Goldberg, 1990). In music preference research from the last 25 years, most studies used these five traits as a comprehensive model of personality (Schäfer & Melhorn, 2017).

Associations between personality and musical preferences

There is an abundance of research investigating correlations between personality traits and musical preferences (e.g. Delsing et al., 2008; Devenport & North, 2019; Fricke & Herzberg, 2017; George, et al., 2007; Langmeyer, Guglhör-Rudan, & Tarnai, 2012; Rentfrow & Gosling, 2003). Recent studies also investigated the associations between perceived attitudes in music and personality (Greenberg et al., 2016) and have been able to link associations between preferences and emphasizing-systemizing cognitive styles (Greenberg, Baron-Cohen, et al., 2015). However, a recent meta-analysis by Schäfer and Melhorn (2017) indicates that

effect sizes are rather small, with $|r|$ between 0.10 and 0.21. On the other hand, a recent large-sample ($N = 22,252$) online study was able to show that musical preferences measured through ratings of audio music examples can be used to predict a person's personality (Nave et al., 2018), at least to a small degree (R^2 values between 0.012 and 0.026). Because of the audio ratings, the application of the MUSIC factors and the comprehensive sample this study is of particular interest for our study. In Table 1 the results of both studies can be seen next to each other indicating that the overall findings are not consistent between these studies, which could be due to the fact that averaged effects in a meta-analysis could be biased by some of the included studies or that the two studies used different approaches to measure musical preferences. In their second study, Nave et al. (2018) used musical preferences as indicated by Facebook likes as predictors and imposed the causal direction (musical preferences predict personality) in their linear regression model with LASSO shrinkage estimation (Tibshirani, 1996), which is contrary to most previous studies that observe correlations between personality and preference and do not impose a specific causal direction a priori. Although there are theoretical and empirical arguments for either causal direction, determining the direction of the causal relationship is very difficult in the absence of longitudinal data.

Table 1: Significant personality and music preference correlations found by Schäfer & Melhorn (2017) and Nave et al. (2018)

	Schäfer & Melhorn (2017)	**$|r|$**	**Nave et al. (2018)**	**r**
Openness	Mellow	0.16	Mellow	-0.12
	Sophisticated	0.21	Sophisticated	0.16
	Intense	0.12	Contemporary	-0.11
Conscientiousness	-		-	
Extraversion	Contemporary	0.12	Unpretentious	0.13
Agreeableness	Unpretentious	0.10	-	
Neuroticism	-		-	

Summarising, our paper aims at the following goals: 1) To test which previously reported associations between personality and music preference can be replicated using a non-verbal music inventory with adolescents, 2) to use data mining techniques that can model complex variable interactions as well as non-linear relationships in order to see how well personality can be predicted from preferences. Such an approach can be considered more powerful than the linear regression with coefficient shrinkage used by Nave et al (2018). The idea behind this approach is to investigate if we can find a personality test based on the ratings of a collection of music excerpts. Theoretically, it is a plausible hypothesis that interactions between the preferences for individual tracks predict personality better than just main effects of preferences for full genres predicting personality traits. This hypothesis can be assessed by statistical techniques that can handle large sets of predictors and also model their potential interactions.

Method

This study used a cross-sectional design where participants were asked to complete a test battery consisting of various self-report questionnaires and perceptual tasks. This paper is complementary to the study by Müllensiefen and colleagues (2015) on the relationship of music self-theories and the development of musical abilities which used the same sample of participants but did not cover musical preferences.

Sample

The 312 pupils (all female, M_{age} = 14.14 years, SD_{age} = 1.92 years) were recruited from the Queen Anne's school, a secondary school for girls in the UK. All pupils participated voluntarily and consent from their parents was sought before data collection. The sample comprises students from all year groups of the school, except the oldest one (age group 17-

18). Therefore, the age ranges from 10 years (only one participant) to 18 years (only four participants).

Procedure

Participants were tested in groups in the school's computer labs during normal school hours. Pupils were seated in front of a computer with attached headphones (Behringer HPM1000). Participants were instructed to work at their own pace through the online test battery. The total duration of the test session ranged from 55 to 75 minutes.

Measurements

Musical preferences

We used the brief version of the MUSIC scale by Rentfrow and colleagues (2011). 25 audio examples were used that represent the five latent underlying music factors: Mellow (M = 5.9, SD = 1.53), Unpretentious (M = 5.14, SD = 1.63), Sophisticated (M = 4.54, SD = 1.49), Intense (M = 4.2, SD = 1.76), and Contemporary (M = 5.02, SD = 1.27). The examples were 15 second excerpts from original recordings in an mp3 format. Participants were then asked to indicate their degree of liking for each of the 25 excerpts using a 9-point Likert scale, ranging from 1 (Extremely dislike) to 9 (Extremely like). Only 264 participants completed this task.

Personality

The big five personality traits were assessed using a version of the Ten Item Personality Inventory (TIPI, Gosling, Rentfrow, & Swann, 2003) that was adapted and tested for children from 10 years of age (Müllensiefen et al., 2015). Results from an initial pilot test indicated that not all younger children (i.e., 10 to 14 years of age) were familiar with all attributes of the original scale. Therefore, synonyms for each of the two attributes of each TIPI item were selected from the collection of personality attributes reported in Goldberg (1990). The selection of two additional attributes for each of the 10 TIPI items was based on ratings of semantic fit and suitability for the target age group by 11 independent judges. As

part of the test session children were asked to indicate on 7-point Likert scales how much they identify with the attributes that describe a trait. All items and descriptive statistics of the TIPI can be found in the Appendix.

Statistical Analysis

Analyses were carried out in *R* version 3.6.0 using the *Hmisc, party* and *lavaan* packages. First, we provide a correlation matrix using mean scores for the MUSIC factors (Table 2) for readers to consider if and how correlational models might be plausible.

Table 2: Correlation matrix of personality and music preference scores

	Openness	**Conscientiousness**	**Extraversion**	**Agreeableness**	**Neuroticism**
Mellow	0.05	0.16**	-0.04	0.20**	0.05
Unpretentious	0.00	0.15*	0.00	0.11	0.04
Sophisticated	0.11	0.14*	-0.20**	0.02	0.06
Intense	-0.03	-0.07	-0.17**	-0.06	-0.07
Contemporary	-0.02	0.11	0.10	0.12	0.09

*Note: **p < .01, *p < .05, N = 264*

Four structural equation models (SEM) were computed to investigate the associations between latent musical preference factors and personality traits. The factor scores for music preferences were estimated from the corresponding manifest variables (i.e. ratings of the audio tracks). The first model specified all possible covariances between the five personality traits and the five preference dimensions (SEM_Full), a second data-driven model reduced all covariances in a stepwise way leaving only significant covariances in the model (SEM_DD), a third model (SEM_MA) specified only those covariances that were identified as significant in the meta-analysis by Schäfer & Melhorn (2017) and the fourth model used the associations found by Nave and colleagues (2018) in a large online sample (SEM_OS).
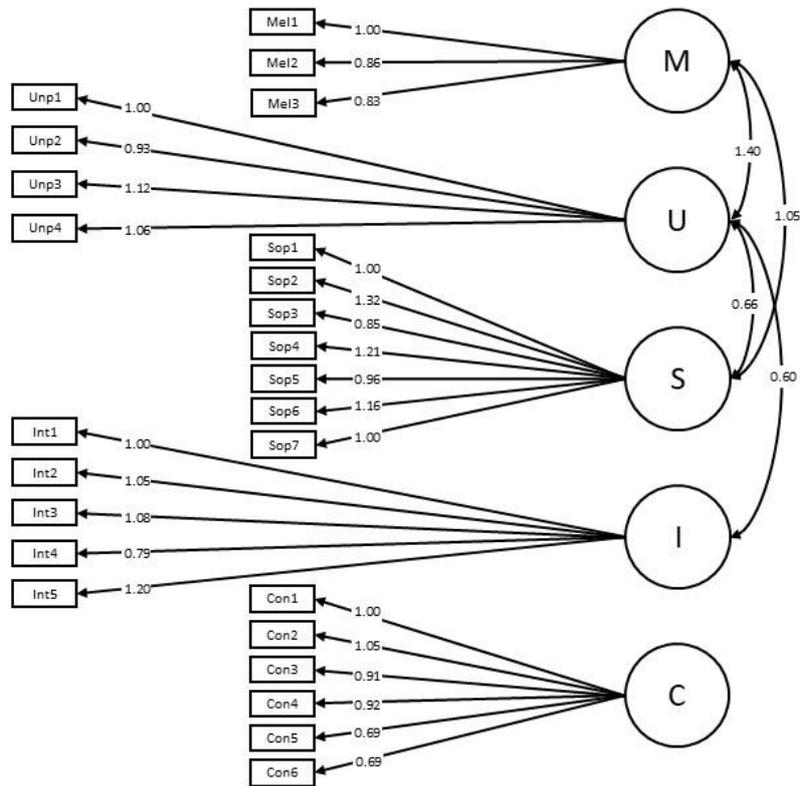
In relation to the second goal of this study we decided to deploy data mining techniques that can exploit non-linear relationships and high order interactions for increasing the predictive power and hence might be able to identify relationships between musical preferences and personality that previous studies might have missed by using correlations, linear regressions, or linear structural equation models. We chose regression trees and a random forest as the corresponding ensemble method (Strobl, Malley & Tutz, 2009) which have gained popularity in psychological research over recent years. For a summary description and an application in a musical context, see Pawley and Müllensiefen (2012).

Results

At first sight, some of the correlations found by previous studies were replicated with the current data (see Table 2). For example, the correlations between preferences for mellow music with agreeableness and conscientiousness or unpretentious and conscientiousness (Bonneville-Roussy et al., 2013) were significant with the current data as well. Unexpectedly, none of the significant correlations from the meta-analysis (Schäfer & Melhorn, 2017) or the large sample online study (Nave et al., 2018) could be replicated at correlational level with our data.

A confirmatory factor analysis (CFA) of the musical preference ratings of the 25 audio clips yielded just about acceptable fit indices for the five-factor solution suggested by Rentfrow and colleagues (2011), $\chi2 = 873.063$, $df = 271$, $p < .001$, CFI $= 0.78$, GFI $= 0.785$, RMSEA $= 0.091$, SRMR $= 0.106$. The CFA is depicted in Figure 1 (Mel/M $=$ mellow, Unp/U $=$ unpretentious, Sop/S $=$ sophisticated, Int/I $=$ intense, Con/C $=$ contemporary).

Figure 1. Confirmatory factor analysis of the five dimensions of musical taste (Rentfrow,

Gosling, & Levitin, 2011), $N = 264$

The same measurement model was used with all subsequent structural equation

models. We used the Bayesian Information Criterion (BIC) for comparing the fit between

models. As anticipated for SEM_Full, not all paths were significant, and the model had the

worst (i.e. highest) BIC value of all models. The model specified according to Schäfer and

Mehlhorn's (2017) meta-analysis (SEM_MA) had a substantially lower BIC value while also

significantly differing from SEM_Full according to a likelihood ratio test (p< .001). The

model following Nave and colleagues' (2018) online study (SEM_OS) had an even lower

BIC, while the data-driven model (SEM_DD) had the lowest BIC. All fit indices can be found

in Table 3. In addition, likelihood ratio tests indicated that SEM_DD has the best fit for the

data, (see Table 3). SEM_MA and for comparison SEM_DD are depicted in Figure 2. The

data driven model shows the closest fit to the data, although assessing model fit on the same

dataset that was used for estimating the model is likely to give rise to overfitting and results

might not replicate in future samples. Out of the remaining three models the model based on the analysis of a large internet sample by Nave et al (2018) performed best.
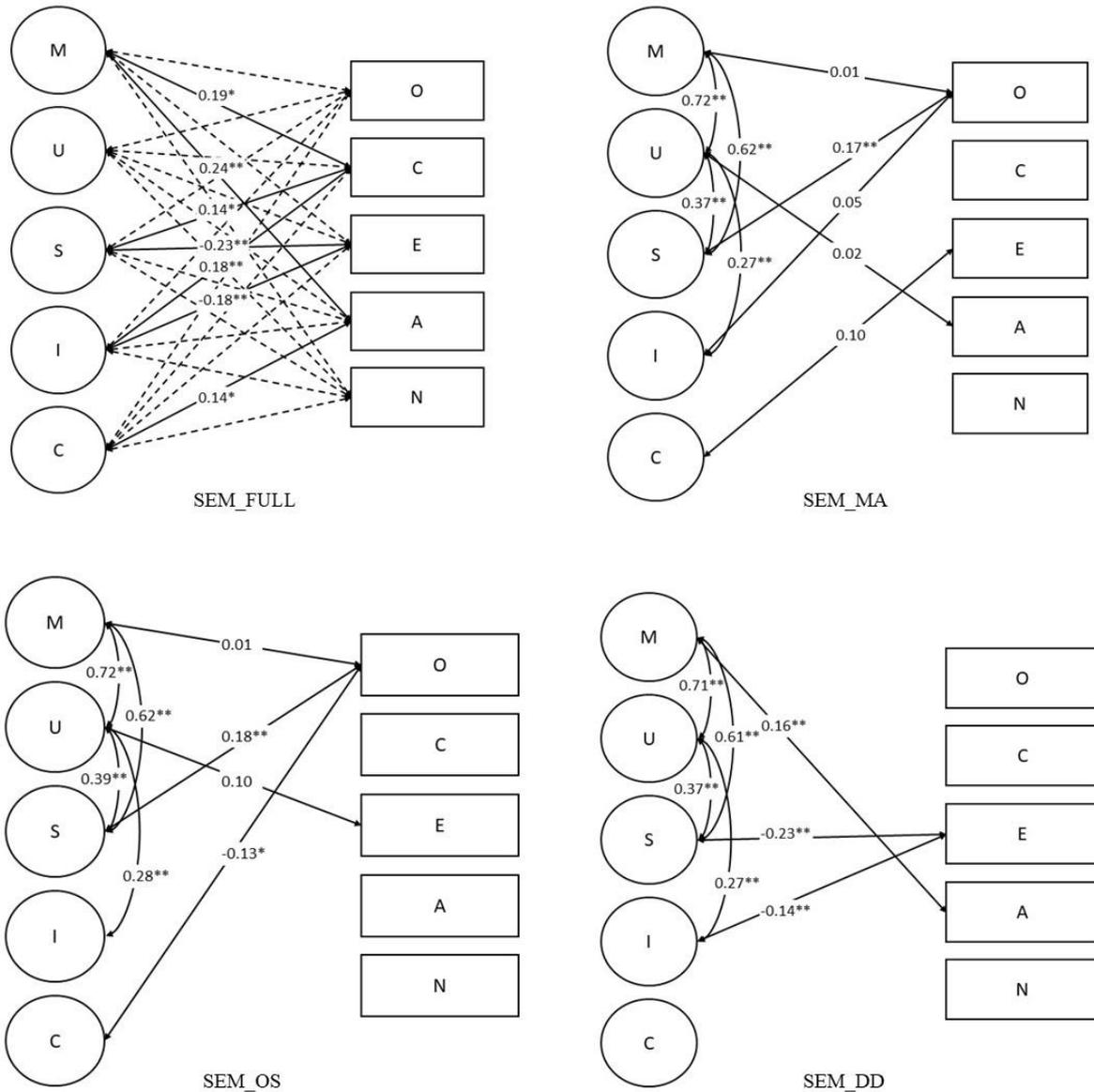
For SEM_MA, only the association between openness and sophisticated ($\beta = 0.171$, $p = .001$) was significant. Openness and sophisticated music preferences ($\beta = 0.179$, $p = .001$) were also associated in the model from the large online study, SEM_OS, which also showed a negative correlation between contemporary music and openness ($\beta = -0.129$, $p = .029$). In the data driven model the associations between extraversion, sophisticated ($\beta = -0.234$, $p < .001$) and intense ($\beta = -0.144$, $p = .008$) as well as agreeableness and mellow ($\beta = 0.156$, $p = .003$) were significant.

Table 3: Comparison of the full, data driven and two theoretical (Schäfer & Melhorn, 2017; Nave et al., 2018) structural equation models

SEM Model	*Df*	RMSEA	SRMR	CFI	AIC	BIC	χ^2	$\Delta\chi^2$	ΔDf	*P*
SEM_FULL	365	0.082	0.086	0.782	30423	30780	1008.7			
SEM_MA	391	0.081	0.096	0.770	30439	30704	1077.4	68.702	26	< .001
SEM_OS	392	0.081	0.101	0.769	30433	30694	1072.9	-4.443	1	1
SEM_DD	393	0.080	0.098	0.776	30412	30669	1053.7	-19.206	1	1

Note: N = 264

Figure 2. Visualisation of the full model, data-driven model and the two models specified according to the results of previous studies (Schäfer & Melhorn, 2017; Nave et al., 2018). All models were computed as structural equation models, coefficients are standardized βs, *p < .05, **p < .01, N = 264.

Next, all 25 individual items from the MUSIC inventory were used as predictor variables for predicting scores on the five personality dimensions using the regression tree technique. The regression trees for conscientiousness, extraversion, and agreeableness are depicted in Figure 3. The trees for openness to experience and neuroticism had no nodes

which means there are no suitable predictor variables. The trees can be interpreted by starting at the treetop following the branches and at each node follow down another branch. The terminal nodes of the tree are represented as boxplots showing the distribution of the personality values in this particular node.
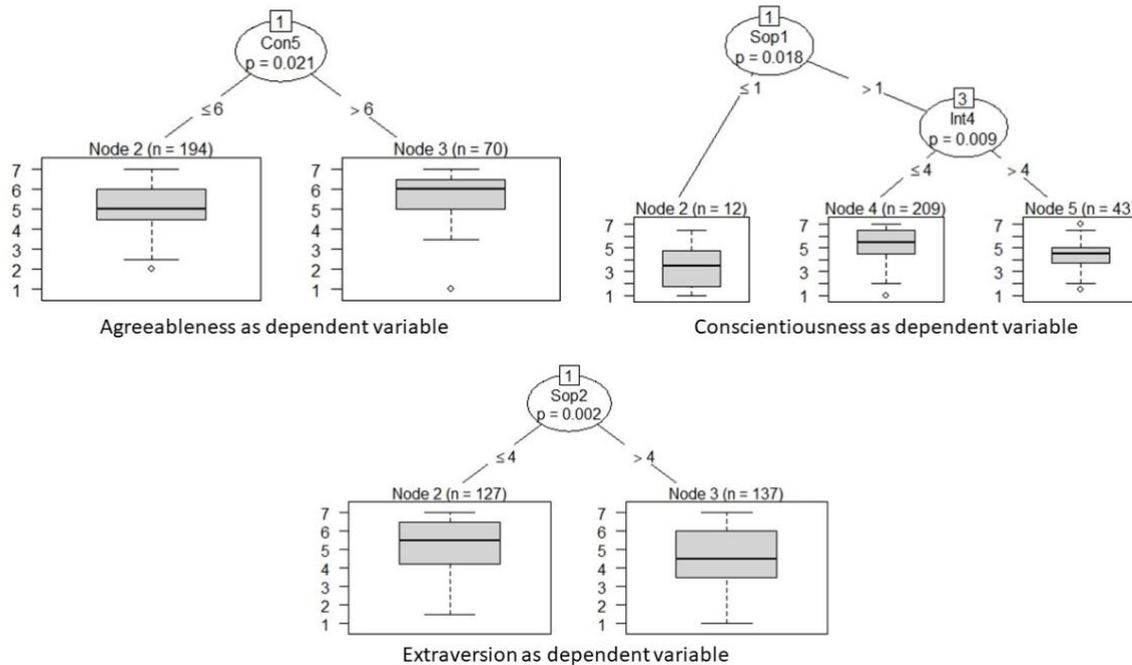

Figure 3. Three single regression trees demonstrating how a contemporary music excerpt predicts agreeableness, how a sophisticated and an intense music excerpt predict conscientiousness, and how a sophisticated excerpt predicts extraversion. The thick black line in the boxplots represents the median personality score of the subset of participants in this terminal node.

Single tree models are easily visualised but can only reflect one specific combination of explanatory variables. However, from a theoretical point of view we hypothesize that several different combinations of musical examples might predict the personality traits. Thus, a model describing just a single musical preference combination is potentially too simplistic and not appropriate.

Therefore, we constructed a random forest model which aggregates the predictions of individual regression trees (Strobl, Malley, & Tutz, 2009). For each tree a bootstrap subset sample is used, and the number of explanatory variables is limited to a small subset of all available predictors. Then for each data point predictions of all tree models are averaged, and these averages serve as the predicted value.

With the 25 MUSIC predictor variables we computed a random forest using 10,000 trees and a subset size of five variables for each tree. Using the built-in cross-validation mechanisms, the model explains 0.6% of the variance in the dependent variable openness to experience, 5.1% for conscientiousness (using two intense and one excerpt from each other dimension), 6.6% for extraversion (using two intense, three sophisticated and one excerpt from each other dimension), 5.1% for agreeableness (using two intense, two mellow, four contemporary and one excerpt from the other two dimensions), and 0.3% for neuroticism. For those three personality traits with more than 5% variance explained, items with high explanatory power come from all five music meta-genres. However, one important observation is that the ratings of the audio tracks from the MUSIC scale cannot explain more than 6.4% of variance for any of the five personality traits.

Discussion

Our results show that using musical preferences cannot be interpreted as a reliable mirror for personality in an empirical way. Little variance is explained using musical preferences as predictors, and only three out of five personality traits seem to be predictable from musical preference judgements at all. The structural equation models showed that there are some associations between dependent variables and independent variables (see Figure 2). Additionally, the results from the structural equation model with the best fit did not replicate any findings from the meta-analysis (Schäfer & Melhorn, 2017). In contrast some findings reported by Nave and colleagues (2018) were replicated in our data driven structural equation

model, specifically the associations between openness and sophisticated music preferences and a negative correlation between contemporary music and openness.

The regression tree and random forest approach showed that using all 25 MUSIC extracts explained only a small amount of variance for agreeableness, conscientiousness, and extraversion, while openness to experience and neuroticism could not be predicted to any meaningful degree using musical taste items. This contradicts the results by Nave et al (2018) who found that openness and extraversion where the best predicted traits but supports the finding reported by Schäfer and Melhorn (2017) that associations between musical preferences and personality are generally weak. Following the results of the data mining techniques, it does not seem possible to establish a meaningful personality test based on music preference. Nevertheless, future studies might want to apply these techniques with larger and more representative participant samples as well as larger item collections, also taking accounting for interactions between music excerpt ratings.

Limitations

Our findings replicated some findings from previous studies, but some frequently reported findings like the association between music preferences and openness were not found. This could be due to some limitations of this study. First, the SEMs were not a good fit for the data. This could be explained by the special sample (all female and young) that was used. A mixed gender sample with more diverse demographic background would have provided more variance. Second, the final sample we used was comparably small which limits the scope of our results. Third, girls at an all-girl private school seem to rate themselves highly on openness to experience in general. This leads to a ceiling effect for this trait which could explain why openness could not be predicted by musical preferences like in previous studies (e.g., Rentfrow & Gosling, 2003). Future studies should again focus on pupil samples with more diverse demographic backgrounds and pupils from both genders. Fourth, the big

five scale we used (TIPI) is a very brief measurement which does not possess the same psychometric reliability as longer scales. Additionally, future studies might want to consider using other personality measurements that look closer at facets of personality traits such as more explicit subdimensions of the big five traits (e.g., Greenberg, Baron-Cohen, et al., 2015) rather than broad representations like the big five, other psychological traits, for example empathy (Greenberg, Rentfrow, & Baron-Cohen, 2015), and other dimensions of musical preferences, like using the basic attributes arousal, valence, and depth (e.g., Greenberg, et al., 2016; Fricke et al., 2018). Finally, future studies might want to take situational variation into account. Models that assume personality and preferences to be stable across different contexts could not capture situational variation, although it plays a critical role in trait-related behaviour (Mischel & Shoda, 1995).

Conclusion

While it is theoretically plausible that musical preferences can contribute to the assessment of personality, our results suggest that the contribution of music preference ratings to the prediction of personality scores might be limited. Although it is a very attractive idea to infer an individual's personality only from their musical taste, it seems as if researchers still need to rely on traditional self-report inventories or at least will need to include additional preference and lifestyle variables as well.

Acknowledgments

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Appendix

Ten Item Personality Inventory (TIPI; Gosling, et al., 2003) – extended

Personality trait	Item (I see myself as…)	M	SD
Openness	open to new experiences, complex + *curious, thoughtful*	5.51	1.09
	conventional, uncreative + *shallow, simple*		
Conscientiousness	dependable, self-disciplined + *responsible, persistent*	5.03	1.39
	disorganized, careless + *lazy, irresponsible*		
Extraversion	extraverted, enthusiastic + *sociable, lively*	4.8	1.52
	reserved, quiet + *shy, private*		
Agreeableness	sympathetic, warm + *kind, patient*	5.19	1.26
	critical, quarrelsome + *grumpy, selfish*		
Neuroticism	anxious, easily upset + *touchy, fearful*	4.57	1.41
	calm, emotionally stable + *independent, peaceful*		

Note. $N = 312$, all items were measured on 7-point Likert scales, ranging from 1 (Disagree strongly) to 5 (Agree strongly)