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Intelligence and Musical Mode Preference

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Abstract

The relationship between fluid intelligence and preference for major–minor musical mode was investigated in a sample of 80 university students. Intelligence was assessed by the Raven's Advanced Progressive Matrices. Musical mode preference was assessed by presenting 14 pairs of musical stimuli that varied only in mode. Mood and personality were assessed, respectively, by the *Brief Mood Introspection Scale* and the *Big Five Questionnaire*. Preference for minor stimuli was related positively and significantly to fluid intelligence and openness to experience. The results add evidence of individual differences at the cognitive and personality level related to the enjoyment of sad music.

Keywords

musical mode, intelligence, personality, mood

Music Mode and Emotions

The enjoyment of sad music and the individual differences linked to this phenomenon have received much attention in recent years (see, for a review, Sachs, Damasio, & Habibi, 2015). For example, Vuoskoski, Thompson, McIlwain, and Eerola (2012) found that sad music is often connected to the experience of more complex emotions such as nostalgia, peacefulness, and wonder. The enjoyment of sad music is related to the specific personality traits of openness to experience and empathy (Vuoskoski et al., 2012). Garrido and Schubert (2011) also found that absorption and music empathizing were the best predictors of sad music

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preference. The appreciation of sad music is mood congruent and is greater among individuals with high empathy and low emotional stability. Nostalgia, rather than sadness, is the most frequent emotion evoked by sad music (Taruffi & Koelsch, 2014). In line with this research, we aimed to specifically investigate the role of fluid intelligence in this phenomenon. Expression of sadness and happiness in musical stimuli was manipulated via musical mode (major–minor, see Appendix).

All else being equal (e.g., intensity, tempo, rhythm, and timbre), music using the intervals of the major scale tends to be perceived as relatively happy, bright, or martial, whereas music using the minor scale tends to be perceived as more subdued, sad, dark, or wistful (Bowling, 2013; Burkholder, Grout, & Palisca, 2005; Cooke, 1959; Costa, Ricci Bitti, & Bonfiglioli, 2000; Crowder, 1984, 1985; Heinlein, 1928; Hevner, 1935; Kastner & Crowder, 1990; Lahdelma & Eerola, 2016; Maher & Berlyne, 1982; Parncutt, 2014).

The distinction emerges also in the linguistic domain: German uses the word *Dur* (from Latin *durus*, "hard") for *major* and *moll* (from Latin *mollis*, "soft") for *minor*. Similarly, the 16th-century Italian music theorist and composer Gioseffo Zarlino described the effect of the major mode as "gay and lively" and the minor mode as "sad and languid" (Zarlino, 1558/1968, pp. 21–22). In Costa et al. (2000), minor bichords were perceived as more dull, mysterious, gloomy, and sinister. Moreover, minor bichords were judged as weaker and bewildering.

Costa, Fine, and Ricci Bitti (2004) found mode to be the best predictor for valence assessment in melodies. Using a priming paradigm, Costa (2013) showed that mode also significantly influences cognitive processing. In the affective priming paradigm, major or minor chords can facilitate the categorization of congruent affective words. This shows that the emotional valence of musical stimuli differentiated by mode can be shared by ongoing cognitive processes. Similarly, Bakker and Martin (2014) have shown by using event-related potentials and simultaneously presented musical chords and facial stimuli that emotional connotation of musical chords can be processed as early as 200 milliseconds. This early recognition suggests that major and minor chords have deep connections with emotional meanings (Bowling, 2013).

Some studies have explored a possible equivalent of musical mode in the vocal domain. Bowling, Gill, Choi, Prinz, and Purves (2010) and Bowling (2013) have reported that the spectra of major intervals are more similar to spectra found in excited speech, whereas the spectra of particular minor intervals are more similar to the spectra of subdued speech. Furthermore, Curtis and Bharucha (2010) have shown that the minor third interval occurs in the pitch contour of speech conveying sadness. Huron (2008), calculating the average melodic interval size for nearly 10,000 Western classical instrumental themes, found that the average interval size is slightly smaller for themes written in the minor mode compared with themes written in the major mode. As small pitch movements are found in sad speech prosody, small melodic interval sizes may contribute to the perception of sadness in minor melodies.

Intelligence and Music

The relationship between intelligence and music has been explored in four main areas: (a) the distinctive role of musical intelligence among the intelligence types identified by Gardner (1983), (b) the relationship between general intelligence and auditory discrimination, (c) the possible contribution of music training in developing intelligence in nonmusical domains, and (d) how intelligence modulates music fruition and music preference. These four approaches are reviewed briefly later.

The first approach consisting of Gardner's (1983) multiple intelligences posits at least eight fairly independent types of intelligence have evolved in the human species and are valued in a wide range of cultures. Musical intelligence, which is not measured by conventional intelligence tests, includes sensitivity to various musical properties and the ability to appreciate, produce, and combine pitch, tones, and rhythms. Musical intelligence is presumed to develop more or less independently from other kinds of intelligences and, unlike the others, it requires the ability to discriminate between pitches. In addition, musical intelligence has a particular type of notation and symbol system that is different from that of mathematical or linguistic intelligence.

The second approach originates from studies that have explored the connections between sensory discrimination and psychometric intelligence (Deary, 2000). Brand and Deary (1982) showed that subjects who scored better on psychometric intelligence tests required less stimulus duration to make accurate pitch discrimination. Further research with this type of task has revealed small to moderate significant associations with measures of psychometric intelligence (Deary, Caryl, Egan, & Wight, 1989; Deary, Head, & Egan, 1989; Irwin, 1984). Research using more standard psychoacoustic tasks in groups of students found more substantial associations (i.e., $r \approx .5$) between tests of auditory discrimination and cognitive test scores (Raz, Willermann, Ingmundson, & Hanlon, 1983; Raz & Willerman, 1985). Deary (1995) tested competing structural equation models of the cross-lagged associations between psychometric intelligence and auditory processing in 13-year-old children and concluded that low-level processing might be partly causal to later intelligence differences. A similar effect was obtained using loudness-based auditory discrimination instead of pitch discrimination (Olsson, Bjorkman, Haag, & Juslin, 1998).

Auditory processing abilities are also a component of the Cattel–Horn–Carroll (CHC) model of cognitive abilities (Brown, 1928; Carroll, 1993; McGrew, 2009). Auditory abilities in this model include a wide range of abilities involved in the interpretation and organization of sounds, such as discriminating patterns in sounds and musical structure (often under background noise or distorting conditions), and the ability to analyze, manipulate, comprehend, and synthesize sound elements, groups of sounds, or sound patterns.

A third approach has explored how music training could enhance intelligence. Schellenberg (2011), for example, found that children with voice or keyboard musical training exhibited greater increases in full-scale IQ. The effect was relatively small but was generalized across IQ subtests, index scores, and a standardized measure of academic achievement. Lynn, Wilson, and Gault (1989) similarly showed that tests of the analysis of music were positively associated with general intelligence among 9- and 10-year-old children. The music tests involved accuracy rather than speed, confirming the thesis that accuracy of neural transmission and analysis are components of intelligence.

The fourth approach focuses on the role of intelligence on music fruition and music preference. Previous research has shown that intelligence has a critical influence in music preference. Rentfrow and Gosling (2003) showed that more intelligent individuals preferred "reflective, complex, and intense" genres of music (which included classical, jazz, blues, and folk). According to George, Stickle, Rachid, and Wopnford (2007), preference for rebellious music is associated to a marginally lower IQ. Those who prefer classical music were found to be more educated and more intelligent, a result that was confirmed also by Kanazawa and Perina (2012).

Also Hendricks, Robinson, Bradley, and Davis (1999) found that those who listen to rebellious music are more likely to have lower grades in school. Less intelligent individuals preferred upbeat and conventional music. Chamorro-Premuzic and Furnham (2007) found that more intelligent individuals are more likely to use music for cognitive purposes. Intelligence, on the contrary, was not correlated with the emotional use of music. Furnham and Chamorro-Premuzic (2004) found a positive correlation between aesthetic judgment and measures of general intelligence.

In the present study, preference for major–minor mode was associated with fluid intelligence as measured by the *Raven's Advanced Progressive Matrices* (APM) *Test* (Raven, 1994; Raven, Raven, & Court, 1993, 1998). This test is widely used to measure problem-solving ability or *educative ability* (Raven et al., 1993), fluid intelligence (Cattell, 1963), and analytic intelligence (Carpenter, Just, & Shell, 1990). The score does not rely on an explicit base of knowledge derived from previous experience (Carpenter et al., 1990; Sternberg, 2000). The APM has been found to yield reliable scores as a measure of general intelligence and is correlated .74 with the full-scale *Wechsler Adult Intelligent Scale* and .75 with the Otis IQ (McLaurin, Jenkins, Farrar, & Rumore, 1973). As Carpenter et al. (1990) have shown, the APM measures the common ability to "decompose problems into manageable segments and iterate through them, the differential ability to manage the hierarchy of goals and subgoals generated by this problem decomposition, and the differential ability to form higher level abstractions" (p. 429).

Mood, Personality, and Musical Preferences

A mood scale was used in order to test the extent to which preference for the major or minor mode was related to contextual factors. The liking of sad-sounding music was shown to increase after a sad-mood induction paradigm (Hunter, Schellenberg, & Griffith, 2011). Previous research has highlighted the fact that individuals usually tend to listen to music which is congruent with their mood. Friedman, Gordis, and Förster (2012), for example, found that individuals in a sad mood were strongly averse to listening to happy songs. The preference for mood-congruent music was also confirmed by DeMarco, Taylor, and Friedman (2015).

There is evidence, however, to suggest that this congruency effect may differ across individuals. Some people appear to be motivated to select music that is congruent with their mood while others are motivated to select music that is incongruent with their current mood (Taruffi & Koelsch, 2014). People who score higher on a measure of global empathy, fantasy, and personal distress and who score lower on measures of emotional stability were more likely to listen to sad music when they were in a negative mood (Taruffi & Koelsch, 2014).

In addition to mood, we also investigated personality using the *Big Five Questionnaire* (BFQ; Caprara, Barbaranelli, & Borgogni, 1993; Caprara, Barbaranelli, Borgogni, & Perugini, 1993). Personality was assessed in order to investigate whether mode preference was related to the levels of extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience. Connections between music usage and personality have been investigated by Chamorro-Premuzic, Gomà-i-Freixanet, Furnham, and Muro (2009). Individuals higher in neuroticism were more likely to use music for emotional regulation (influencing their mood states), those higher in extraversion were more likely to use music as background to other activities, and those higher in openness to experience were more likely to experience music in a cognitive or intellectual way. Openness to experience has been shown to have the greatest effect upon genre preference (Nusbaum & Silvia, 2011). Individuals high in openness to experience prefer more complex, novel, intense, and rebellious music (Rentfrow, Goldberg, & Levitin, 2011; Langmeyer, Guglhör-Rudan, & Tarnai, 2012).

Self-estimates of intelligence were also linked to use of music. Chamorro-Premuzic and Furnham (2007) found that individuals with higher IQ tended to use music in a rational/cognitive way, while neurotic, introverted, and non-conscientious individuals were all more likely to use music for emotional regulation. IQ was also associated with preferences for particular musical styles.

Our hypothesis was a positive association between preference for the minor mode and the APM fluid intelligence score. Furthermore, in relation to personality, we expected a confirmation of previous results about the association between openness to experience and the enjoyment of sad musical stimuli.

Method

Participants

Eighty university students participated in this study: 60 females (mean age: 21.28 ± 2) and 20 males (mean age: 21.50 ± 1.27). The students were enrolled in psychology courses and were recruited on a voluntary basis; 14 (17.5%) were classified as musical experts having more than 5 years of specific musical training: 8.57 ($\pm$3.29) years. The study was approved by the Ethical Committee of the University of Bologna, and each participant signed an informed consent form in order to adhere to the experimental protocol.

Intelligence Assessment

Intelligence was assessed by the APM (Raven et al., 1998). Set 1 was used for instructional purposes while Set 2 was used for experimental purposes. The APM administration was time limited to 40 minutes.

Mood Assessment

The *Brief Mood Introspection Scale* (BMIS, Mayer & Gaschke, 1988) consists of 16 mood adjectives (e.g., "Are you happy?"). The scale can yield measures of overall pleasant–unpleasant mood, arousal–calm mood, and it can also be scored according to positive-tired and negative-calm mood. Items were rated on a 4-point Likert-type scale (ranging from *definitely do not feel* to *definitely feel*).

Personality Assessment

The BFQ consists of 132 items related to five domain scales. For each of the items in the questionnaire, there is a 5-point answer scale that ranges from complete disagreement (1 = *very false for me*) to complete agreement (*very true for me*). T-scores were computed for each of the five domain scales according to the BFQ manual (Caprara et al., 1993).

Musical Stimuli

Mode preference was assessed by presenting 14 pairs of musical stimuli that varied only according to mode: major versus minor (Figure 1). The stimuli were not part of known musical composition and were composed by the first author according to these criteria: (a) time duration of about 2 seconds, (b) flute synthesized timbre in order to minimize the contribution of harmonics and to emphasize the fundamental tone, (c) legato between the notes to avoid an emphasis on rhythmic percussion in the transition between notes, and (d)

Figure 1. Pairs of musical stimuli differing in mode used in the study.

isochronous notes (same duration). The stimuli were major and minor chords, either melodically or harmonically arranged (Figure 1).

Each pair was presented twice, counterbalancing mode; 50% of the pairs consisted of the major stimulus followed by the minor stimulus. In the other pairs, the order was reversed. Order of presentation between the 14 pairs was randomized. After listening to each pair of stimuli, participants were requested to express their preference for the first or second stimulus. Furthermore, they were requested to indicate the degree of preference on a scale from 1 (*slight preference*) to 5 (*extreme preference*). The scoring of mode preference was done by assigning positive values to major mode preference (from 1, *slightly preference* to 5, *extreme preference*), whereas minor mode preference scores were converted to negative values (from −1, slight preference to −5, extreme preference).

Procedure

The order of data collection was (a) general data, (b) preference for major–minor stimuli, (c) *BMIS*, (d) *BFQ*, (e) *Raven's APM* Set 1 for instructional purpose and exercise, and (f) *Raven's APM* Set 2.

Statistical Analysis

Zero-order Pearson correlations between mode preference, APM score, personality, and mood scales were computed first. Hierarchical regression analysis was then conducted to assess the specific contribution of the different predictors (APM score, personality, and mood scales), and two control variables (age and expertise), to the variance of the dependent variable (mode preference). Finally, partial correlations were examined between mode preference, APM score, personality, and mood scales in order to partial out overlapping variance between the three predictors.

Results

Table 1 shows the full correlation matrix between mode preference and Raven's APM score, all personality scales, mood scales, and expertise. The table shows a strong correlation between mode preference and Raven's APM. Mode preference was also significantly correlated with openness to experience and with the gloomy mood scale.

The correlation analysis was complemented by a hierarchical regression analysis that allowed a more strict control on variable manipulation. The hierarchical regression analysis was performed treating mode preference as the dependent variable. Independent variables were entered in five steps. The first step included the five personality scales from the BFQ, the second step included

Table 1. Correlation Matrix Between Mode Preference and Raven's APM Score, Personality Scales, Mood Scales, and Expertise.

	Raven's APM score	Extraversion	Agreeableness	Conscientiousness	Openness to experience	Emotional stability	Gloomy	Overall mood	Expertise
Mode preference	−**.42*****	.06	−.20	.22*	−**.23***	.07	−**.28****	.07	−.16
Raven's APM score	—	−.03	.07	−.07	.14	−.10	−.006	−.08	.18
Extraversion		—	−.09	−.08	.27*	−.06	−.19	.31**	−.03
Agreeableness			—	−.21	−.08	.24*	.20	−.20	−.08
Conscientiousness				—	−.18	−.12	−.09	.14	−.04
Openness to experience					—	.12	.05	.08	.02
Emotional stability						—	.26*	−0.31**	.07
Gloomy							—	−0.46**	−.003
Overall mood								—	−.002

Note. APM = Advanced Progressive Matrices.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2. Hierarchical Regression Analysis Results Considering Mode Preference as the Dependent Variable.

Variable	R	Adjusted R^2	R^2 change	F change	p
Personality scales	.41	.11	.17	3	.01
Mood scales	.65	.20	.25	1.48	.14
Age	.65	.19	.001	.12	.73
Expertise	.66	.19	.01	1.37	.25
APM	.71	.27	.06	6.82	.01

Note. APM = Advanced Progressive Matrices.

all the mood scales from the BMIS, the third step included age, the fourth step included expertise, and the final step included the key independent variable that was the APM score. Table 2 shows the results of the hierarchical regression analysis with the contributing factor for each model. APM and the personality scales contributed significantly to the regression model. Among the personality scales, openness to experience was a significant predictor of mode preference. Other personality scales were not significant predictors. The final model explained 27% of the variance.

As mode preference significantly correlated with multiple predictors (APM score, conscientiousness, openness to experience, and the gloomy mood scale), it was critical to compute partial correlations that considered the singular contribution of each predictor. Significant partial correlations emerging from the hierarchical regression were (a) mode preference and APM score: $pr(54) = -.34$, $p < .001$ (controlling for personality and mood scales), (b) mode preference and openness to experience: $pr(54) = -.28$, $p = .014$ (controlling for APM score and the mood scales), and (c) mode preference and gloomy mood: $pr(54) = -.38$, $p = .003$ (controlling for APM score and the personality scales). The collinearity analysis produced variance inflation factor values in the range of 1.020 to 1.771. These low values show a very reduced collinearity between the variables.

Discussion

The results of this study demonstrated a significant association between preference for the minor mode and fluid intelligence. The correlation between minor mode preference and fluid intelligence, controlling for personality, and mood scales was .34, which is moderately high. A first possible explanation of the preference for the minor mode by more intelligent individuals could be a possible link between intelligence, stimulus complexity, and aesthetic preference (Berlyne, 1974). Minor stimuli could be considered as more complex than major ones. In the acoustical domain, the major mode arises from the first five partials in the harmonic series (C-C-G-C-E), the first three without considering the repetition of the fundamental tone (C), while the minor third emerges in the harmonic series as the interval between the fifth and sixth partial.

That the minor mode is of greater complexity can also be concluded through a consideration of the mathematical pitch ratio (Aldwell, Schachter, & Cadwallader, 2010; Burkholder et al., 2005). The major third has a pitch ratio of 5:4, while the minor third has a pitch ratio of 6:5. According to this hypothesis, intelligent individuals would prefer stimuli that, on a sensorial level, exhibit more complexity. Future studies could test whether this complexity hypothesis could be applied also to more complex and dissonant chords such as unresolved chords (diminished and augmented chords). Intelligent individuals, in this sense, could have an enhanced *openness* to dissonance.

Major and minor chords not only differ on the level of perceptual complexity but also have a qualitative difference that cannot be explained simply in terms of a gradient of dissonance–complexity. For example, using a functional magnetic resonance imaging (fMRI) approach, Cook (2002) and Fujisawa and Cook (2011) have found distinct brain activations for resolved (i.e., major and minor) and tension chords (i.e., augmented and diminished), underlining the qualitative difference between these two categories.

An alternative or complementary explanation of this association could rely on an association between preference for negatively valenced stimuli and intelligence. A recent study by Penney, Miedema, and Mazmanian (2015) has provided some evidence to this effect. They found that verbal intelligence was a positive predictor of worry and rumination in a sample of nonclinical population. In turn, intelligence was related to worriedness, an affect that in music is more associated to the minor mode than the major one. Similar results were found in a clinical population by Coplan et al. (2012, 2006). Our results contribute to the definition of individual differences linked to the preference for sad musical stimuli (Sachs et al., 2015).

This hypothesis could be tested in a future study in which individuals differing in the Raven score assess their preference for stimuli differing in emotional valence. It would be interesting to test whether the preference for sad stimuli in more intelligent individuals is extended also to visual affective stimuli and not only to musical ones.

Openness to experience was found to be a significant predictor of mode preference. We found a significant correlation between openness to experience and preference for the minor mode. Of all personality traits, openness to experience is the one that has been shown to have the greatest effect upon genre preference. Rawlings and Ciancarelli (1997) have investigated music preference as a function of the personality traits. In their research, openness to experience was to be associated with a preference for a wide range of music types. Also Dunn, de Ruyter, and Bauwhuis (2011) have found that those high in openness to experience prefer more complex and novel music like classical, jazz, and alternative. Langmeyer et al. (2012) found an association between openness to experience and preference for intense and rebellious music. A positive correlation between openness to experience and liking complex music was found by Chamorro-Premuzic, Fagan, and Furnham (2010).

Our results involving the influence of openness to experience on preference for the minor mode mirrors data found by Vuoskoski et al. (2012) in which a positive association was found between the trait of openness to experience, preference for sad music, and the intensity of emotional responses induced by sad music. The most common feelings described from sad music were nostalgia, peacefulness, and wonder, and openness to experience was correlated positively with all those feelings. Openness to experience is related to a sensitivity to art and beauty (McCrae & Sutin, 2009) and to the experience of aesthetic chills in response to music (Nusbaum & Silvia, 2011). The construct of openness has also been suggested to be related to intelligence both theoretically and from the results of correlational studies (e.g., Austin, Deary, & Gibson, 1997; Austin et al., 2002; Harris, 2004; Moutafi, Furnham, & Crump, 2003). DeYoung, Quilty, Peterson, and Gray (2014) have confirmed this association for verbal intelligence only. Silvia and Sanders (2010) did not find the relation between fluid intelligence and openness to experience.

The association between gloomy mood and preference for the minor mode is in line with previous evidence of a mood-congruent effect in music preferences (Hunter et al., 2011; Taruffi & Koelsch, 2014). In this article, intelligence was correlated with preference for the minor mode; however, further research is needed to better understand the causal model underlining this association. Moreover, whether intelligence can impact preferences in structural aspects of music other than mode, such as tolerance to dissonance, atonality, and timbre complexity, remains to be clarified. In addition, building on the results of the present study showing a link between intelligence and mode preference, it would be interesting to investigate whether this association is valid only for fluid intelligence or also for other types of intelligence (e.g., linguistic, spatial, bodily kinesthetic, interpersonal, and intrapersonal). Similarly, given that in this study happiness/sadness was manipulated with music mode only, it would be interesting to test whether the association between fluid intelligence and minor mode can also be confirmed through the use of more complex musical stimuli such as standardized excerpts evoking sadness and happiness.

Appendix

A great deal of music worldwide employs subsets of the chromatic scale, which divides each octave into 12 intervals, defined by specific frequency ratios between two component notes (Burkholder, Grout, & Palisca, 2005; Carterette & Kendall, 1999; Nettl, 1956; Randel, 1986). Among the most commonly used subsets are the diatonic scales, the eight-note musical scales composed of seven pitches, and the repeated octave. The scale can be divided into 12 equal semitones, which is the smallest interval in the Western music system. Two equal semitones form a whole tone.

All major scales use the interval pattern: 2-2-1-2-2-2-1, where 2 designates a whole tone (e.g., C-D) and 1 designates a semitone (e.g., E-F). The interval pattern for the natural minor mode is: 2-1-2-2-1-2-2 (Aldwell, Schachter, & Cadwallader, 2010; Burkholder, Grout, & Palisca, 2005). The most salient difference between the major and minor modes is the interval of third between the first and third scale degree. The major mode is characterized by a major third (frequency ratio of 5:4), whereas the minor mode is characterized by a minor third (frequency ratio of 6:5).

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