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Maladaptive music listening strategies are modulated by individual traits

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Abstract

Music listening is a great resource for mental well-being, pleasure, and self-regulation, but it may also be maladaptive: depression, for instance, has been shown to relate to music use that is characterized by rumination, avoidance and mood worsening. However, we know little of the role of individual differences in such maladaptive music use. Hence, this study focused on examining the role of personality, empathic traits, emotional contagion, and the types of musical reward as predictors of maladaptive music listening. Participants (N = 318) answered an online survey comprising measures for the above mentioned traits in addition to the *Healthy-Unhealthy Music Scale* (HUMS) as a measure of maladaptive music use. Results demonstrated that *Unhealthy* musical engagement was predicted by a variety of traits representing general negative emotionality (e.g. *Neuroticism*, *Personal Distress*, contagion for negative emotions). Structural Equation Modelling highlighted the importance of the empathic trait *Personal Distress* in mediating *Unhealthy* musical engagement. Finally, we deliberate if maladaptive strategies are indeed 'maladaptive' for such individuals or merely a coping mechanism, which is indeed adaptive for them, aiding to combat depressive and anxious states thereby preventing them from "tipping over" into depression.

Keywords: Well-being, Personality, Mental health, Individual differences, Empathy, Depression risk, Maladaptive music usage

1. Background

Music listening serves several important psychological functions in peoples' lives, supporting our emotional, social, and mental needs (Maloney, 2017; Schäfer, Sedlmeier, Städtler, Huron, 2013). Music can support mental health and wellbeing in many ways: it increases connectedness to others, be a resource for constructing identity (DeNora, 2001;

McFerran, Derrington, & Saarikallio, 2019; Ruud, 2017), or serve as a tool for mood regulation by helping to distract from worries, to relax and revive, to gain energy and reach strong sensations, to facilitate mental processing of experiences, and to find solace, comfort and emotional validation (Baltazar & Saarikallio, 2016; Saarikallio, 2011).

While acknowledging the major potential of music for health, researchers have also questioned whether music is always helpful and health-beneficial. Indeed, music engagement has been shown to relate to measures of ill-health, too, including externalizing symptomatology such as problem behavior (Mulder, Ter Bogt, Raaijmakers, & Vollebergh 2007; North & Hargreaves, 2012) and internalizing symptomatology such as depression (Doak, 2003; Lacourse, Claes, & Villeneuve, 2001; McFerran, Garrido, & Saarikallio, 2013; Miranda & Claes, 2009). Music listening has been identified to be maladaptive for instance in terms of music engagement becoming addictive, orverstimulative, and detrimental to hearing (Reybrouck, Podlipniak, & Welch, 2019; 2020). Music has also been identified as a potential tool for inefficient coping strategies such as avoidance (Miranda & Claes, 2009) and rumination (Garrido & Schubert, 2013). It has even been noted that listeners may trust music to be good and helpful for them even if it actually is not benefiting their health (McFerran & Saarikallio 2014). In the current paper, we argue that in order to fully understand when, why, and for whom music is health-beneficial, it is also crucial to address cases in which it is not. We add one piece to the puzzle of understanding the predictors of maladaptive music use in light of individual differences.

In the current paper we address maladaptive usage of music in respect to mental health, focusing specifically on music engagement that is linked with a risk for depression. The Healthy-Unhealthy Music Scale (HUMS) was developed as a tool to assess maladaptive ways of musical engagement that are associated with proneness to depression (Saarikallio, Gold, & Mcferran, 2015). It consists of two subscales: HUMS *Healthy* assesses music use that relates to experiencing positive emotions, relaxation and social connection; HUMS *Unhealthy* assesses the use of music for rumination, avoidance and mood worsening. HUMS *Unhealthy* strongly correlates with depressive symptoms. Other studies have confirmed that the use of music for rumination (Garrido & Schubert, 2013) and avoidant coping (Miranda & Claes, 2009) relates to depression. Depressed individuals have also been associated with a predilection for sad music (Garrido & Schubert, 2015). In the naturalistic context of music listening through online streaming platforms, it has been found that individuals scoring high on psychological distress and HUMS *Unhealthy* demonstrate greater reliance on music and repetitive usage of music, especially related to *Sadness* extracted from social tags and acoustic features (Surana et al. 2020a; Surana et al. 2020b).

The question remains, however, whether there are other determinants in addition to depression risk itself for this kind of music engagement style: can a person's more general emotional dispositions or the type of rewards they typically seek from music explain whether they engage in music listening that is characterized by rumination, avoidance, and mood-worsening? Some researchers argue that the health-impacts of music listening are dependent on our general tendencies and capacities of using affective resources, for example, tendency for positive reappraisal (Miranda, Gaudrea, Debrosse, Morizot, & Kirmayer, 2012; Chin & Rickard, 2014). Also, our capacity to cope with music as a sound environment may vary (Reybrouck, Podlipniak, & Welch, 2020), or individuals may be more or less competent in using music to increase emotional awareness and emotional agency (Saarikallio, 2019).

One significant factor contributing to emotional dispositions and mental health is personality. Individuals differ in terms of their characteristic patterns of thought, emotions, and behaviour, and personality traits are one way of characterizing and measuring these differences. The Five-Factor Model of personality (McCrae & Costa, 1987; also known as the 'Big Five', see e.g., John & Srivastava, 1999), comprising the traits *Extraversion , Neuroticism, Agreeableness, Conscientiousness,* and *Openness to Experience*, has emerged as the dominant personality theory in recent decades (e.g., John et al., 2008). Out of these five broad personality traits, all but the trait *Conscientiousness* are related to emotion dispositions (e.g., Reisenzein & Weber, 2009; John & Srivastava, 1999). In particular, *Extraversion* is associated with positive emotionality, while *Neuroticism* is associated with the tendency to experience negative emotions such as anxiety, worry, and tension (e.g., Reisenzein & Weber, 2009; Derryberry & Reed, 2002). People with high *Neuroticism* are also more susceptible to depression, possibly due to emotion dysregulation (Paulus et al., 2016). In relation to music preferences, *Extraversion* has similarly been found to correlate with a preference for happy-sounding music, while *Neuroticism* has been associated with the opposite trend (Vuoskoski & Eerola, 2011a).
Agreeableness, a prosocial trait related to kindness, tender-mindedness, trust, and modesty, associated with a tendency to be less anger-prone (Kuppens, 2005) and to control negative emotions in communication situations (Tobin et al., 2000), has been found to correlate positively with a preference for happy- and tender-sounding music, and negatively with preference for scary-sounding music (Vuoskoski & Eerola, 2011). Finally, *Openness to Experience* is understood as the tendency to be imaginative and curious, to have wide interests, and to appreciate arts and aesthetic experiences. These tendencies seem to apply to the musical domain as well, since *Openness to Experience* has been linked with an increased sensitivity to experience pleasurable chills when listening to music (Nusbaum & Silvia, 2011), and people with high *Openness to experience* tend to prefer more diverse and complex styles of music (such as classical and jazz; Rentfrow & Gosling,

2003), as well as music expressing negative emotions such as *Sadness* and *Fear* (Vuoskoski & Eerola, 2011b).

In addition to the BigFive personality traits, empathy and emotional contagion are tendencies that may have associations with the maladaptive use of music. Considerable amount of research supports the fact that people with depression and depressive tendencies are more susceptible to and gravitate towards negatively valenced stimuli (Garrido et al. 2015; Gotlib, Krasnoperova, Neubauer Yue, & Joormann, 2004; Wenzlaff & Bates, 1998; Raes, Hermans, & Williams, 2006). Furthermore, certain individual traits seem to moderate the susceptibility of becoming impacted by such stimuli. Emotional contagion indeed measures an individual's predisposition to "catching" and sharing another's experienced emotional state relying on external cues (Doherty, 1997). In addition, several studies report that individuals with high emotional contagion, especially to sad and negative states, such as social workers dealing with depressed clients, are more prone to experiencing negative and depressed moods (Bakker, Schaufeli, Sixma, & Bosveld, 2001). Siebert et al. (2018) report that susceptibility to emotional contagion was indeed associated with burnout and depression.

Similarly, trait empathy has been associated with both the predilection for sad music and the susceptibility to be affected by music (Eerola et al. 2012). *Perspective Taking (PT)* and *Fantasy Seeking (FS)* constitute the *cognitive* component of the emotional system which in turn drive the *affective* component comprising *Empathic Concern (EC)* and *Personal Distress (PD)*. *PT* refers to the tendency to shift one's own perspective to that of another individual, or to put it plainly, the ability to see things from another person's (or thing's) point of view. *FS* is similar to *PT* with the main difference that it is one's tendency to project oneself into the situation of a fictional character. *EC* is related to one's capacity to experience feelings of sympathy or concern towards the perceived affective state of another individual. *PD* relates to one's tendency to undergo distress when observing others' negative experiences and is known to correlate positively with neuroticism.

It has been observed that individuals who suffer from depression are prone to experiencing high levels of *Empathic Stress* (PD) when presented with a stressful situation of another person due to internalizing it and as a result experience distress due to potential resurfacing of past emotional pain. In contrast, *Empathic Concern* is associated with experiencing more positive, other-oriented emotions such as compassion and sympathy in response to others' distress, contributing to altruistic behaviour (Eisenberg, 2000). O'Connor et al. (2007) clearly outline how empathy is linked to depression and specify that the empathic system might be on overdrive sometimes. They also outline that individuals with depressive tendencies are reported to have intense concern for others but fail to demonstrate effective action owing to dysfunctional regulation of their own emotions

arising due to internalizing of others' negative states (Batson, Early, and Salvarani, 1997; O'Connor et al., 2007). As stated by O'Connor et al. (2007), this results in a "severance between empathic concern and acts of altruism". Furthermore, one of the two variants of the BDNF gene (i.e., Brain-derived Neurotropic Factor) related to trait neuroticism and several conditions including depression and anxiety disorders, was also found to inhibit altruistic actions (O'Connor et al. 2007; Brunoni, Lopes, and Fregni, 2008). Hence, one could hypothesize that individuals prone to depression display withdrawal tendencies from and non-inclusivity in social situations, which as a result may require the individual to create a less negative and potentially safer environment using music as a coping strategy.

The concepts of emotional contagion and empathy inherently relate to our sensitivity towards the emotions of others (Doherty, 1997; Eisenberg, 2000) The onset of depression is also likely to be a result of lost attachments and social connections which might be potential resources for biological regulation (McGuire and Troisi, 1998). Higher risk of depression is associated with high empathy in childhood (Klimes-Dougan and Bolger, 1998). This explains why, given our current disconnected lifestyles, music acts as a social surrogate which potentially allows some to find a virtual other to regulate their emotions and mood states. Schäfer and Eerola (2020) demonstrated the important role played by music as a social surrogate in a general population functioning to provide a sense of *Company, Comfort*, and *Shared Experiences*. The last function indeed shares an underlying mechanism with emotional contagion and empathy. Music indeed appears to be a vital source of fundamental social support needed for the human species, especially in this digital age of social disconnectedness, to mentally keep well. However, it remains to be seen if using music as a social surrogate can potentially be all but a temporary replacement for real-world social interactions and it is indeed important to identify individual-specific variations in strategies which may or may not be beneficial for their well-being. For instance, an Extrovert who actively exhibits prosocial behavior might not be as affected by using music as a social surrogate, owing to their drive to seek real-world interactions, while a highly neurotic person might be further isolating themselves by retreating into their own virtual world which in the end might not be beneficial. Our study aims at understanding such inter-individual differences in music listening strategies by looking into their personality and empathic traits.

In sum, personality and emotionality guide our behavior in many ways, including musical behavior. It seems they also play a role in determining what types of rewards people typically seek and gain from music listening (Chamorro-Premuzic & Furnham, 2007; Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, & Rodriguez-Fornells, 2013). *Openness to experience,* for instance, relates to a great variety of different types of musical rewards across social, sensori-motor, and emotional aspects of music (Mas-Herrero et al, 2013), while *Neuroticism*, *Introversion* and low *Conscientiousness* particularly relate to a greater

use of music for emotional self-regulation (Chamorro-Premuzic & Furnham, 2007). Whether these different types of rewards in turn are associated with the maladaptiveness of music engagement has not been studied. This paper aims to shed light on whether particular types of personality and affective traits and particular types of musical rewards relate to maladaptive music listening, as defined by avoidant, ruminative, and mood worsening aspects that are known to relate to higher risk for depression. We combine several measures of individual differences as it is important that they be investigated jointly to reveal the complex interplay among them and the relation to music listening strategies thereof.

2. Aims and hypotheses

The goal of this study was to identify whether and how maladaptive music engagement (assessed by HUMS *Unhealthy,* referring to ruminative, avoidant, and mood worsening music use*)* are associated with and predicted by *personality and emotional traits (*Personality and Affective Traits), and by the *kinds of rewards that people draw from the music* (Musical Rewards). Personality and affective traits consist of Individual-specific traits and tendencies represented by personality, emotional contagion, and empathy, while the Musical Rewards consist of the different rewards that music provides (assessed by BMRQ).

2.1 Personality and Affective Traits

*Personality and Affective Trait*s addressed in the current study consisted of the following: The Big Five Personality dimensions, empathy (Interpersonal Reactivity Index, IRI, Davis, 1980), and Emotional Contagion (Doherty, 1997). Based on the aforementioned links between *Neuroticism*, *Personal Distress*, and depression, we expect *Unhealthy* scores to be positively associated with *Neuroticism* and negatively with *Extraversion.* Furthermore, we expect to find individuals with high *Unhealthy* scores to be more susceptible to negatively valenced emotional contagion factors represented by *Sadness, Fear and Anger*. Concerning trait empathy, we expect *Unhealthy* scores to correlate positively with *Personal Distress* and negatively with *Empathic Concern.*

2.2 Musical Rewards

The Barcelona Music Reward Questionnaire (BMRQ) was developed by Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, & Rodriguez-Fornells (2013) to identify underlying factors underlying diverse reward experiences associated with music. Based on the social surrogacy theory and prior research on depressed individuals' music engagement, we hypothesize that individuals with high *Unhealthy* scores may rely heavily on music by actively seeking music and immersing themselves into it in order to escape their current

states, as indicated by the "*Music Seeking*" and "*Emotional Evocation*" subscales of BMRQ. In the current study, since the major focus is on Personality and Affective traits, the association between *Musical Rewards* alone and maladaptive traits will be reported in Supplementary material.

3. Method

3.1 Participants

A total of 318 Participants (Age *M* = 32 years, *SD* = 12.45, 138 males) completed an online survey. Participants were recruited through the mailing lists of universities and Prolific, with a small monetary compensation provided for responding. Most respondents were undergraduate and master students, and primarily non-musicians (31% reported having some musical training, ranging from 6 months to 37 years). Out of this 31%, the mean was 5.28 yrs (std=4.84 yrs) of musical training. Informed consent was acquired from all participants prior to data collection.

3.2 Measures

The measures consisted of HUMS, Interpersonal Reactivity Index (IRI), Emotional Contagion Scale (ECS), Big-Five Inventory (BFI), and BMRQ. These all are previously validated self-report measures for surveys. HUMS (Saarikallio, Gold & McFerran, 2015) has sub-scales for *Healthy* and *Unhealthy* music engagement styles derived from 13 items rated on a 5-point scale ranging from *never* to *always*.

The IRI (Davis, 1980) assesses four facets of Empathy: *Perspective Taking (PT), Fantasy (FS), Empathic Concern (EC)*, and *Personal Distress (PD)*. Answers are provided on a 5-point scale ranging from *Does not describe me well* to *Describes me very well*. The Emotional Contagion Scale is a 15-item questionnaire measuring the susceptibility to 'catching' the emotions of others. Specifically, the ECS measures the contagion of five different emotions: *Happiness, Sadness, Fear, Love*, and *Anger* (three items each).

Barcelona Music Reward Questionnaire (BMRQ) (Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, & Rodriguez-Fornells, 2013) assesses five types of musical reward experiences using 20 items rated on a 5-point likert scale ranging from *Completely Disagree* to *Completely Agree.* The five types of musical reward comprise the following: *Musical Seeking (MS)* representative of a heavy reliance on music and musical seeking; *Emotion Evocation (EE)* depicting intense immersive musical experiences; *Mood Regulation (MR)* representative of music as a social surrogate for the primary purpose of relaxing or calming oneself; *Social Reward (SR)* that predominantly captures the prosocial aspect involving sharing music and actively engaging in playing with others; and *Sensory-Motor (SM)* capturing an embodied musical experience be it in the form of movement or singing.

3.3 Analyses

First, in order to assess the reliability of the data, we calculate Cronbach alphas. We then check if the variables in our study are normally distributed using the Lilliefors normality test (Lilliefors, 1967), which would determine our choice of either parametric or nonparametric statistical tests for subsequent analyses. The variables that fail the normality test are subjected to the Box-Cox transformation (Box and Cox, 1964), a technique used to transform a non-normal variable into a normal variable. Post transformation, the variables are again checked using the Lilliefors test since transformation does not always guarantee that the variable will be transformed to a normal distribution. In the case that they are not normally distributed, we opt for nonparametric equivalents of statistical tests.

We then assessed correlations among the Personality and Affective Traits measures which further acts as an additional metric for evaluating internal consistency of the dataset. Then we calculated correlations between HUMS *Healthy* and *Unhealthy* and Personality and Affective Traits and Music Reward measures. Subsequently, we performed regression to predict *Healthy* and *Unhealthy* (dependent variables) from Personality and Affective Traits and Music Reward measures (independent variables). We further examined the underlying affective dimensions of *Personality and Affective Traits* using Principal Component Analysis and examined the correlations of the emergent components with *Unhealthy*. Based on these correlations we selected the most relevant measures of Personality and Affective Traits and explored causal dependencies between them in explaining *Unhealthy* scores using structural equation modelling (SEM). SEM is a commonly used modelling technique in the field of psychology that permits estimation of causal relationships between variables. This approach can be thought of as a combination of factor analysis and linear regression, thereby allowing us to define predictive models that best fit our observations (i.e., *Unhealthy)*. We therefore create several such models based on apriori hypotheses of causal relations among variables and as a result identify the one that best fits our data.

4. Results

4.1 *Reliability and validity assessment of measures*

Cronbach's alpha reliabilities for HUMS in our data were 0.77 for *Unhealthy* and 0.84 for *Healthy*. All the factors of personality (BFI) and empathic traits (IRI) demonstrated acceptable reliability (all Cronbach alpha ≥ 0.73). For BMRQ, similar cronbach alphas were found (all cronbach alpha ≥ 0.7) with the exception of MS demonstrating borderline acceptability (cronbach alpha = .65). With the exception of trait *Extraversion*, the remaining variables failed Lilliefors test of normality post Box-Cox transformation, hence we used nonparametric statistical tests for subsequent analyses. Spearman Correlations between *Personality and Affective Traits* is reported in Supplementray Table 1. Since the main reason for performing correlations among the *Personality and Affective Traits* was to add internal consistency to our data, we do not delve into explaining each and every observed

correlation but rather highlight overarching patterns. Overall, the correlation patterns among the *Personality and Affective Traits* were in concordance with longstanding past research studies in the field and thus add to the internal consistency of the data (See Supplementary Material for details). Finally, the presence of several significant correlations suggests multicollinearity and further motivates the need to unearth underlying factors and utilize appropriate prediction approaches that accounts as described in the following sections.

4.2 Personality and Affective Traits and Musical Rewards associated with *Healthy and Unhealthy music engagement*

Figure 1 displays correlations between Personality and Affective Traits and HUMS *Healthy* and *Unhealthy.*

INSERT FIGURE 1 HERE

Personality and Affective Traits revealed distinct profiles for *Healthy* and *Unhealthy.* Significant positive correlations were observed between *Healthy* and emotional contagion of positive emotions such as *Happiness* (r = .39, p < .001) and *Love* (r = .32, p < .001) in addition to positive correlation of moderate effect size (all r >.20, p < .001) with all factors of trait empathy except *Personal Distress*. Furthermore, a higher *Healthy* score was associated with high scores on the personality traits *Extraversion, Agreeableness,* and *Openness.* In terms of maladaptive music engagement (HUMS *Unhealthy*), the most significant positive correlations were observed with *Personal Distress* (IRI) (r = .34) and *Neuroticism* (BFI) (r = .25), (all p < 0.001). Partial correlations revealed higher *Unhealthy* scores to be significantly associated with high *Personal Distress* (r = .36, p < .00001) and low *Empathic Concern* (r = -.12, p < .05). In addition, higher emotional contagion of negatively valenced emotions represented by *Sadness* and *Anger* (all p < .05), and lower contagion of *Happiness* (r = -.16, p < .005) was associated with high *Unhealthy* score. Furthermore, in line with our hypotheses, significant positive correlation was observed between *Unhealthy* and *Neuroticism* while traits *Agreeableness* and *Conscientiousness* exhibited negative correlation (all p < .005).

Results of the correlations between the BMRQ factors and *Healthy* and *Unhealthy* are reported in Supplementary material (see Supplementary Figure 1). All BMRQ factors correlated positively with *Healthy* and *Unhealthy.* Specifically, partial correlation controlling for *Healthy* scores revealed a significant correlation between *Unhealthy* and *Emotional Evocation* (r = .17, p < .005), *Musical Seeking* (r = .15, p < .01), and *Social Reward* (r = .11, p < .05), supporting our hypothesis of *Unhealthy* being related to emotional evocation and musical seeking.

4.3 *Personality and Affective Traits and Musical Reward predicting Healthy-Unhealthy music engagement*

We first performed ordinal regression to identify the Personality and Affective Traits and Types of music rewards that best predict *Healthy* and *Unhealthy.* Ordinal regression was done as it is the nonparametric analog to ordinary least squares regression. Furthermore, due to the inherent multicollinearity in Personality and Affective Traits observed as significant correlations in Table 1, we also employed ridge regression, as it is less affected by multicollinearity and compared the results. Multicollinearity implies correlation between independent variables which can lead to several unwanted effects, such as inaccurate estimates of regression coefficients, degrade model predictability, amongst others. Table 1 displays the results of the regression models.

INSERT TABLE 1 HERE

From Table 1, a higher proportion of the variance can be explained for *Healthy* (68%) than *Unhealthy* (34%). However, any value of McFadden R^{2}[1] between 20% to 40% is considered a very good fit (Louviere et al. 2000). *Healthy* music listening strategies appear to have major contributions from types of musical rewards, while *Unhealthy* demonstrates a greater contribution from *Personality and Affective Traits*. Since the focus of this paper is on *Unhealthy* strategies and factors that determine such behaviour, we focus on interpreting those results. Both regression models reveal similar contributions (beta coefficients and significance values) from the predictors. Higher *Unhealthy* scores are associated with higher *Neuroticism* (β= .09, p < .05)*, Extraversion* (β=.17, p<.001), *Personal Distress* (β=.30, p<.001)*, Perspective Taking* (β=.26, p<.001)*,* and lower *Empathic Concern* (β=-.38, p<.001) and contagion of *Happiness* (β=-.47, p<.05). Minor differences in the models can be seen in terms of emotional contagion: higher *Unhealthy* scores are associated with higher susceptibility to *Fear* (β=.36 , p<.05) and with a borderline (p = .08) contribution of *Sadness* (β=.31) only in the ridge regression model. In terms of Musical Reward, higher *Unhealthy* scores are characterized by higher *Musical Seeking* (β=.25 , p<.05) and lower *Sensory Motor* (β=-.25, p<.01) factors. The ridge regression model further evidences the positive contribution of *Emotional Evocation* (β=.23 , p<.05) to *Unhealthy* scores. In order to visualise the output of the ridge regression model, both the actual and predicted *Unhealthy* data was plotted against the two variables that it correlated with the most (i.e., *Neuroticism* and *Personal Distress)* (Figure 2). As can be seen from Figure 2, the model appears to perform relatively well owing to the overlap

[1] The McFadden R^{2} is conceptually analogous to the variance explained in Ordinary Least Squares Regression and Ridge Regression. The greater the value the better the model fit.

between the actual and predicted data. Findings of the regression analyses are largely in line with the correlations and provide further confirmation for the original hypotheses.

INSERT FIGURE 2 HERE

4.2 *Dimension reduction of Personality and Affective Traits into predictors of maladaptive music engagement via structural equation modeling*

Owing to the inherent correlation among the various traits, we performed ordinal principal component analysis (PCA) with Varimax rotation to capture the underlying dimensions. The first four components had Eigenvalues greater than 1 and accounted for 64.8% of the cumulative variance. Table 2 displays loadings of the traits on four components. We chose to exclude the musical reward factors, in order to place focus on *Personality and Affective Traits*, which emerged particularly relevant for explaining *Unhealthy (*as compared to *Healthy*.)

INSERT TABLE 2 HERE

The first component was labeled ***Negative emotionality,*** as it was representative of *Neuroticism*, *Personal Distress* and emotional contagion of negative emotions such as *Sadness, Anger, and Fear*. The second component was labeled ***Prosocial traits*** since it had high loadings for traits such as empathy (Perspective Taking and Empathic Concern) and personality including *Agreeableness* and *Conscientiousness.* The third PC was labeled ***Positivity seeking*** as it demonstrated high positive loadings from *Extraversion*, and emotional contagion of positive emotions such as *Love* and *Happiness* in conjunction with moderate negative loadings from *Neuroticism.* Finally, the fourth component was labeled ***Fantasy immersion***, as it revealed high positive loadings from trait *Openness* and *Fantasy Seeking* and negative loadings of *Conscientiousness*. The correlation between the 4 PCs and *Unhealthy* can be seen in Figure 3.

INSERT FIGURE 3 HERE

Unhealthy exhibits most significant correlation with PC1, *Negative Emotionality* (r=.29, p<.001; partial r=.28, p<.001) followed by significant negative correlation with PC2, *Prosocial Traits* (r=-.16, p<.001; partial r=-.22, p<.001) and significant positive correlation with PC4, *Fantasy Immersion* (r=.13, p<.05), which turns out to be insignificant when correlated partially (partial r=.09, p=n.s). *Healthy* on the other hand exhibits significant positive correlation with all the PCs except *Negative Emotionality* (all p<.001).

Since PC1 correlated most with *Unhealthy* (Figure 3), we further performed SEM to uncover potential causality underlying the key variables of PC 1 (*Personal Distress, Neuroticism*, and emotional contagion of *Fear, Sadness* and *Anger*) and their contribution to *Unhealthy* listening strategies. This analysis was exploratory in nature hence we refrained from putting forth any hypothesis regarding the underlying structure of causal relations that would best fit the data. Details of the SEM analyses, including check for multivariate normality and criteria assessing goodness-of-fit, are reported in the Supplementary Material. Here we discuss the results of the explored models.

First, using the variables that load highly onto PC1 (i.e., *Personal Distress, Neuroticism, Sadness, Anger, Fear*), we first investigated how well it explains *Unhealthy* scores without using any intermediate variables similar to a linear fit. This model, labelled as PC1_model, visible in Figure 4, demonstrated an acceptable fit but failed to satisfy some of the model-fit index criteria as evidenced by its sub-optimal root-mean-square-error-of-approximation (RMSEA) and adjusted-*p* value (Hooper and Mullen, 2008) as reported in Table 3. A more detailed analysis of the PC1_model is reported in the Supplementary material.

INSERT FIGURE 4 HERE

We further attempted to improve this model by imposing certain specifications based on the PC loadings. Since *PD* demonstrates the highest correlation with *Unhealthy* (Figure 1) and in addition to scoring the highest loading of .81 in PC1, we chose *Personal Distress* as the intermediate variable that would potentially mediate the effects of the other variables on the *Unhealthy* scores and called this model Model_PD (Figure 5a). Similarly we generated a similar model replacing *PD* with *Neuroticism* since it follows *PD* in terms of correlations and loadings and named it Model_N (Figure 5b). Finally, we also created alternate versions of both these models wherein the variable other than the intermediate variable has a direct effect on *Unhealthy*. For example, in the case of Model_PD, adding a direct connection to *Unhealthy* from *Neuroticism* is labelled as Model_PD_N (Figure 5c) whereas Model_N_{PD} (Figure 5d) is that wherein *Neuroticism* is the intermediate variable with an additional direct effect on *Unhealthy* from PD. This was done to investigate the following hypothesis: *Neuroticism* as a trait might render an individual highly susceptible to stress and negative effects thereby potentially causing them to score higher on *Personal Distress.* This increased distress may then lead to greater reliance on music to regulate their states albeit in a maladaptive *Unhealthy* fashion. The four models can be seen in Figure 5. A double-headed arrow between the variables indicates a noncausal relation and represents the correlation between them. The terms e1 and e2 refer to disturbance variables and are related to the amount of unexplained variance in the predicted variable

and is representative of a composite error. The lack of these terms indicate that the intermediate variable is an exact linear combination of the other variables that precede it. However, error terms are naturally accounted for as part of structural equation modelling, while the main criteria that are crucial in assessing the goodness-of-fit of the model are mentioned in Table 3 (Hooper et al. 2008; Dion, 2008).

INSERT FIGURE 5 HERE

INSERT TABLE 3 HERE

As can be seen from Table 3, the models with direct effects of *Personal Distress* (i.e., Model_PD, Model_PD_N, and Model_N_{PD}) on *Unhealthy* demonstrate best fits as evidenced by highest GIF indices and low chi-squared values. Furthermore, the low RMSE and AIC values for these models further suggests that Model_PD proves to be the best fit based on the results. A noteworthy finding is that Model_N proves to be sub-optimal based on almost all the recommended criteria. This suggests that it is *Personal Distress* that directly mediates *Unhealthy* listening strategies, despite the direct effects of *Neuroticism*. Overall, *Neuroticism* as a mediating variable without direct effects of *Personal Distress* on *Unhealthy* performed worse than the respective counterparts with *PD* as the mediating variable.

5. Discussion

To the best of our knowledge, there have been no studies that have identified relationships between underlying personality and affective traits that might be associated with maladaptive musical engagement. Overall, our findings confirm our hypothesis of negative emotionality (*Neuroticism, Personal Distress* and contagion of negative emotions) being related to and predictive of unhealthy (ruminative, avoidant and mood-worsening) music engagement. Unexpectedly, although *Extraversion* was found to correlate negatively with traits representing negative emotionality and with unhealthy musical engagement, it turned out to be a positive contributor in predicting such engagement. Furthermore, this study uncovers for the first time the kinds of musical rewards associated with healthy and unhealthy music listening styles. We further explored causal dependencies between the personality and affective traits relating to negative emotionality and *Unhealthy* thereby evidencing *Personal Distress* as a key mediating variable that determines unhealthy music engagement.

According to the correlation results, susceptibility to negative emotions (contagion of *Sadness, Fear*, *Anger*) and dysfunction in regulating emotional states (*Personal Distress, Neuroticism*) relate to music engagement with *Unhealthy* strategies. *HUMS Unhealthy* also

demonstrates negative correlations with prosocial traits (*Agreeableness*, *Conscientiousness)*. These findings are in line with prior knowledge on depression. *Neuroticism* has been widely accepted as the predominant trait characteristic of depression and related mood disorders (Klein et al. 2011; Lee 2009) and low *Conscientiousness* has also been reported as a factor contributing to depression risk (Brown and Rosellini, 2011). This could imply that proneness to anxiety, reduced prosocial behaviour, and dysfunctional regulation of negative emotions may render avoidance of certain social situations which could be perceived as stressful and may lead to social isolation. This in turn could result in using music as a social surrogate in a maladaptive way.

Emotional bias towards negative emotions, greater susceptibility to negative affect, has also been demonstrated to be a typical characteristic of depression (Bourke et al., 2010). The high positive correlation between *Unhealthy* and emotional contagion of *Sadness* is also in agreement with the findings of Garrido et al. (2015), who reported that individuals with depressive tendencies demonstrate liking for sad music despite potential unhealthy consequences of listening to sad music. This further allows us to posit that individuals scoring high on *Unhealthy* may indeed engage with music that has *Sadness*-related emotional connotations as a means of coping.

In line with previous findings in Schreiter et al. (2013), maladaptive listening strategies depicted by *Unhealthy* scores are indeed associated with high scores on *Personal Distress* and low scores on *Empathic Concern* as evidenced by Figure 1. Connor et al. (2002) reported that severity of depression, which is indirectly reflected by *Unhealthy* score, significantly correlated with *Empathic Distress* (Connor et al. 2002). This further lends support to the notion that individuals with such tendencies withdraw and isolate themselves due to their inability to self-regulate stressful emotions and hence turn to avoidant and ruminatory musical engagement. Furthermore, a positive relationship between emotion regulation abilities and *Empathic Concern* and a negative relationship with *Personal Distress,* have been observed in multiple studies (see Eisenberg, 2000). This may explain why people scoring low on *Empathic Concern* and high on *Personal Distress* would experience abnormal affective empathy while retaining normal cognitive empathy (Schreiter et al., 2013). This might lead to avoidance of certain social situations, leading to further isolation and potentially aggravating depression (Seidel et al., 2010; Troisi and Moles, 1999).

In relation to types of musical reward associated with *Unhealthy*, as hypothesized, individuals prone to depression may rely heavily on music and experience rewarding immersive emotional experiences, which is evidenced by the significant correlation between *Unhealthy* and *Musical Seeking* and *Emotional Evocation* factors. These results

strengthen the claim that depressive tendencies may foster musical immersion as an escape from a reality that is perceived to be adverse. This is in line with prior research that has linked depression with the use of music for avoidant coping (Miranda and Claes 2009).

The question still remains if excessive music usage and seeking intense and immersive sensations is sometimes an adaptive coping mechanism or whether it primarily promotes more avoidant behavior which may result in depression. Intensive musical engagement may lead to music addiction, which may or may not be harmful. Our results are interesting in the light of addiction, sensation seeking tendencies and personality. Higher risk for addiction, albeit of Social media, was indeed found to be associated with higher social (positive) feedback and reward sensitivity for individuals scoring high in *Neuroticism* and *Extraversion* (Marengo et al., 2019). Also, increased S*ensitivity to Reward* was found to correlate positively with *Extraversion* and *Neuroticism* and negatively with *Agreeableness* and *Conscientiousness* (Mitchell et al., 2007). This can potentially explain why *Unhealthy* exhibits a strong positive correlation with *Neuroticism,* moderate positive correlation with *Extraversion,* and strong negative correlation with *Agreeableness.* Similarly, these trends are observed in the coefficients of the regression model with positive contribution from *Extraversion* and negative from *Agreeableness*. This could imply that *Unhealthy* music strategies are typical of individuals who possess high reward sensitivity.

The regression results reveal, in addition to those demonstrated by the abovementioned correlation results, that *Extraversion* positively contributes to predicting *Unhealthy* scores. This is a novel finding and was unexpected especially since trait *Neuroticism* and *Extraversion* are known to exhibit negative correlation between themselves. Farmer et al. (2002) have suggested that high *Extraversion* may serve to protect against depression while *Neuroticism* reflects subclinical depression. Since HUMS measures proneness to depression, individuals who indeed fall into this group are those that are able to cope, albeit using music in a maladaptive way. It could be the combination of these two traits that might in addition prevent them from “tipping over” into the depressed category. Among the types of music reward, an additional finding was that the *Sensory Motor* factor contributed negatively in predicting *Unhealthy* scores*.* We can speculate that the negative contributions from the *Sensory Motor* factor, which is characterized by corporal engagement with music, may be indicative of musical reward being more of a cerebral escape rather than active engagement in the present. Another trait or neurobiological tendency that may hold relevance for explaining our findings is that of being a *Highly Sensitive Person* (HSP) (Aron and Aron 1997), which is described as a heightened sensitivity to external stimulation, internal physiological sensations, and social stimuli. Such individuals are reported to often be *overwhelmed by bombardment to the senses,* predominantly experience high levels of stress and anxiety *and hence* “*escape from their environment to recharge’’* (Benham, 2006, p.1434). Also this sensitivity has been proposed to be associated highly with neuroticism and moderately to openness while being

unrelated to extraversion. This provides an alternate explanation to the positive contribution of both neuroticism and extraversion in predicting *Unhealthy* scores.

Typically, studies on depression and behavioral tendencies focus on either those who have major depressive disorder (MDD) and/or compare them with healthy controls. Studies that sample from non-diagnosed general population are limited, making it challenging to unearth trends in behavior among samples that are *normally distributed around the general population mean* (Berry et al. 2019). In fact, in the study by Berry et al. (2019) wherein non-diagnosed/non-clinical population was studied, higher levels of depression were associated with greater ability to sustain reward sensitivity, albeit in the span of short time intervals. This result was contradictory to many previous studies that had reported decreased reward sensitivity in patients with MDD (Brush et al., 2018). Furthermore, our sample is similar to Berry et al.'s sample in the sense that no a priori condition (ex: diagnosed MDD) was imposed in selecting individuals for the study. Since, HUMS *Unhealthy* is an indirect measure of depression risk, it is likely that such individuals may indeed be able to engage with music, albeit in an unhealthy way, as a coping and cathartic medium. Whether such repeated engagement is a preventive measure for such individuals or might actually have an accumulative negative effect that ends up in developing depression requires a carefully designed longitudinal study.

The PCA results representing four underlying affective dimensions resonate with the results depicted by the aforementioned correlation and regression analyses. The positive correlation exhibited by *Unhealthy* with *Negative Emotionality* and negative correlation with *Prosocial Traits* further highlights that individuals prone to depression tend to internalize negative emotions and engage with music as a coping mechanism, retracting inwards rather than engaging in prosocial behavior.

The SEM results revealed the crucial mediating role of *Personal Distress* in *Unhealthy* listening strategies. Specifically, an individual's tendency to be more anxious and susceptible to negative emotions, which is predominant in high *Neuroticism*, can indeed lead to them experiencing high distress, resulting in the need for alternative mechanisms for coping, which in this case is music. These findings can be discussed in light of neurobiological tendencies as a result of genetic predispositions. Previous studies on twins and trait inheritability have demonstrated *Neuroticism* to be highly heritable (Loehlin, 1982). Similarly Davis, Luce, and Kraus (1994) additionally suggest *Personal Distress* to be heritable owing to shared commonalities it shares with *Neuroticism.*

Our results are similar to Lee's (2009) study wherein empathy was found to play a mediating role between *Neuroticism* and depression. Specifically, they observed that it was the interaction between *Personal Distress* and *Neuroticism* that was found to be a

significant predictor of depression. Students with higher levels of personal distress displayed pronounced effects of neuroticism on depression. In our SEM analyses, the models that had *Personal Distress* as an intermediate variable (Figure 5a, 5b, and 5c) with direct connection to *Unhealthy* gave the best fit of our data. This can be thought of as being analogous to trait *Neuroticism* to be a potential genetic factor which, possibly due to environmental factors, is expressed as *Personal Distress* which then results in maladaptive musical engagement as a means to cope. These results are very much in line with Carnicer and Calderon (2014) who observed that students who were at high risk of experiencing psychological distress resorted to avoidant coping strategies and seeking alternate rewards. To add to this, Noda et al. (2018) found that high distress is related to greater avoidant coping and lower approach coping and concluded that empathy plays a crucial role in selecting coping strategies and resources. So it is possible to surmise that music is a coping resource for such individuals and their strategies may indeed be more adaptive than maladaptive despite leading them to experience negative emotional states (such as feeling worse after listening).

In sum, as mentioned earlier, certain predispositions in addition to maladaptive music listening strategies have been found to be associated with higher-risk of ill mental-health and there is a need to understand what those are to design more appropriate strategies or ways of intervention. Our study attempts to connect the dots by unearthing traits and tendencies associated with maladaptive music listening strategies. Many of the traits predicting unhealthy listening strategies are associated with sensitivity to negative affect, suggesting dysfunctional regulation of negative emotions and hence proneness to depression. Musical Reward related to unhealthy listening strategies suggests individuals prone to depression engaging in active pursuit of music and seeking novel intense emotional experiences. Empathic traits represented by Personal Distress was found to be key in determining unhealthy maladaptive music engagement. This also poses a new question if the music listening strategies are “maladaptive” after all, since they may in fact be coping mechanisms, at least for those who experience high Personal Distress. Further studies can incorporate a clinically depressed sample to examine traits and types of musical rewarding. In addition, investigating the aforementioned high sensitivity as a trait would then allow us to understand the heightened reactivity to stressful and aversive stimuli due to a highly sensitive sensory and limbic system from a biological perspective.

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Table 1: Coefficients of Ordinal and Ridge Regression models that predict *Healthy* and *Unhealthy* using Personality and Affective Traits and Types of Musical Reward. *PT*: Perspective Taking, *FS*: Fantasy Seeking, *EC*: Empathic Concern, *PD*: Personal Distress; *Hap*: Happy, *Lov*: Love, *Fea*: Fear, *Ang*: Anger, *Sad:* Sadness; *E*: Extraversion, *A*: Agreeableness, *C*: Conscientiousness, *N*: Neuroticism, *O*: Openness; SR: Social Reward, MS: Musical Seeking, MR: Mood Regulation, SM: Sensorimotor, EE: Emotional Evocation.

$p < .05$, $^{**}p<.01$, $^{***}p < .001$

	Personality and Affective Traits														Types of Musical Reward				
Ordinal Regression (McFadden R^2)	Personality					Empathy				Emotional Contagion					BMRQ				
	E	A	C	N	O	PT	EC	PD	FS	Ang	Lov	Hap	Sad	Fea	SR	MS	MR	SM	EE
Healthy (68%)	.01	.2	0.1	-.01	.02	-.00	-.02	-.01	.02	-.12	-.15*	.15	.03	.04	.26***	.23***	.66***	-.08*	.02
Unhealthy (34%)	.07***	-.05	0.1	.06*	.00	.09**	-.13***	.11***	.01	-.12	.04	-.19*	.12	.13	.08	.12**	.04	-.09*	.09
Ridge Regression (Adjusted R^2)																			
Healthy (69%)	.04	.02	.02	.01	.02	-.04	-.01	-.00	.02	-.11	-.14*	.15	.00	0.03	.26***	.23***	.65***	-.09*	.05
Unhealthy (35%)	.17***	-.11	.03	.09*	.06	.26***	-.38***	.30***	-.01	-.27	.10	-.47*	.31	.36*	.19	.25*	.19	-.25**	.23*

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Table 2: Loadings of the Personality and Affective Traits on the 4 Principal Components. The factors that contribute most to each component are highlighted in boldface.

		PC 1	PC 2	PC 3	PC 4
Empathy	Fantasy Seeking	.37	.04	.19	**.62**
	Empathic Concern	.36	**.65**	.22	.33
	Perspective Taking	-.02	**.68**	-.04	.51
	Personal Distress	**.81**	-.19	-.10	-.01
Emotional Contagion	Happiness	.30	.41	**.57**	.14
	Love	.22	.10	**.71**	.15
	Fear	**.72**	.24	.18	.19
	Anger	**.54**	.04	.25	.36
	Sadness	**.68**	.28	.34	.07
Personality	Extraversion	-.23	.12	**.76**	.03
	Conscientiousness	-.18	**.66**	.08	-.36
	Openness	.01	.04	.08	**.83**
	Agreeableness	-.03	**.81**	.28	.04
	Neuroticism	**.73**	-.29	-.30	.05
	Variance Explained (%)	29.88	18.96	8.5	7.47

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Table 3: Goodness-of-fit indices for the proposed Structural Equation Models. CFI: Comparative Fit Index; GFI: Goodness-of-Fit Index; TLI: Tucker Lewis Index; RMSEA: Root Mean Square Error Approximation; AIC: Akaike's information criterion; The recommend thresholds for each of the model fit indices that determine how good a model fits the data are obtained from Hooper et al. (2008) and Dion (2008).

	Chi-Square(d.f)	**Chi-Square/df**	**CFI**	**GFI**	**TLI**	**RMSEA**	**AIC**	**Adjusted *p***
Criteria based on Hooper et al. (2008)	n/a	<5.0	>.95	>.9	>.95	<.05	Low	>0.05
Model_PC1	25.83 (8)	3.23	.97	0.973	0.94	0.08	51.83	0.003
Model_PD	3.14 (4)	.79	1.00	0.997	1.01	0.000	37.14	0.558
Model_N	22.09(4)	5.52	0.97	0.978	0.87	0.12	56.09	0.002
Model_PD_N	2.57(3)	0.86	1.00	0.997	1.00	0.00	38.57	0.475
Model_N_{PD}	2.57(3)	0.86	1.00	0.997	1.00	0.00	38.57	0.475

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Figure Captions:

Figure 1: Correlation between Personality and Affective Traits and HUMS Healthy and Unhealthy factors. In addition, partial correlations between Personality and Affective Traits and Unhealthy controlling for Healthy can also be seen.

Figure 2: Relation between the actual and fitted Unhealthy data, Personal Distress and Neuroticism as a result of Ridge Regression.

Figure 3: Correlation between HUMS Healthy and Unhealthy and the four Principal Components. In addition, partial correlations between Unhealthy and the four PCs controlling for Healthy can also be seen.

Figure 4: Structural Equation Model that predicts Unhealthy using the Personality and Affective Traits that contribute the most to PC1 representing Negative Emotionality. The terms e1 through e6 signify errors associated with the measured variables.

Figure 5: Structural Equation Models that predict Unhealthy using the Personality and Affective Traits that contribute the most to PC1 with Personal Distress and Neuroticism as intermediate variables. The terms e1 and e2 are disturbance terms as it is the error associated with the prediction of the respective observed variables.

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Figure 1:

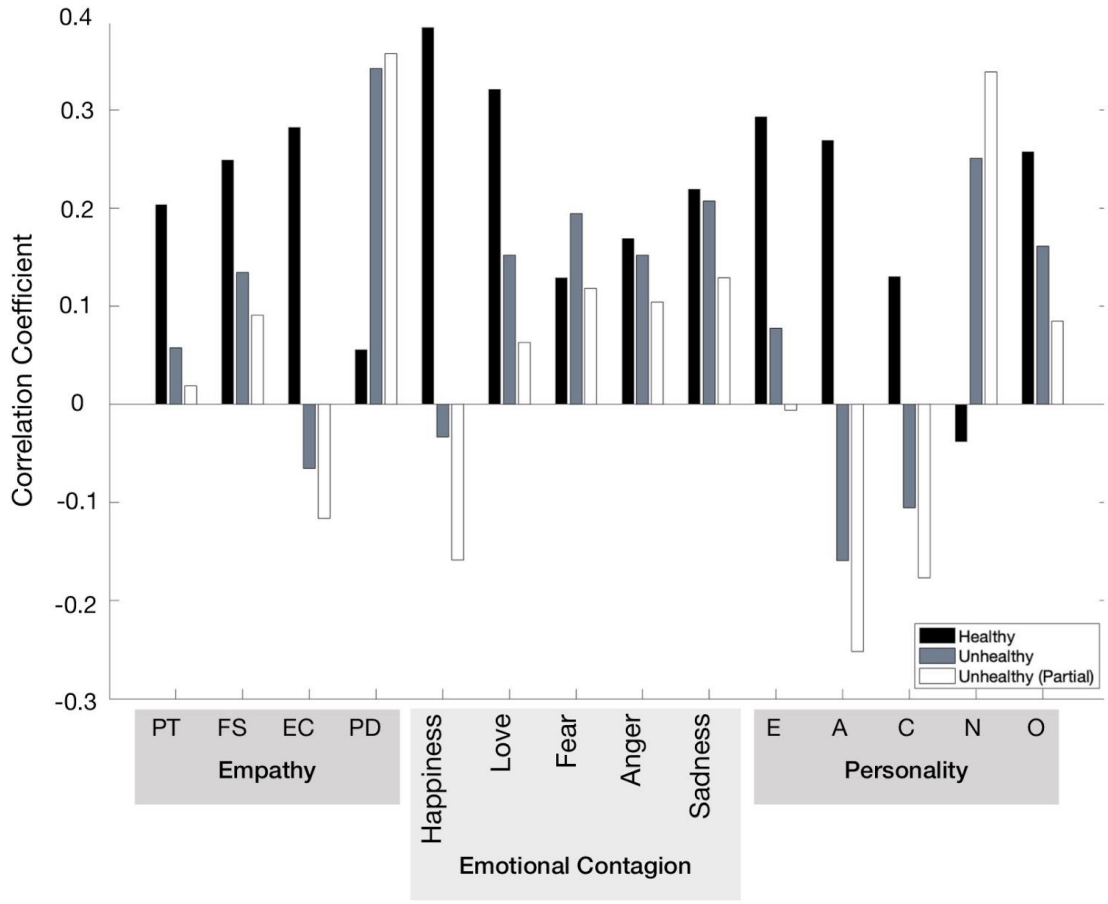

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Figure 2:

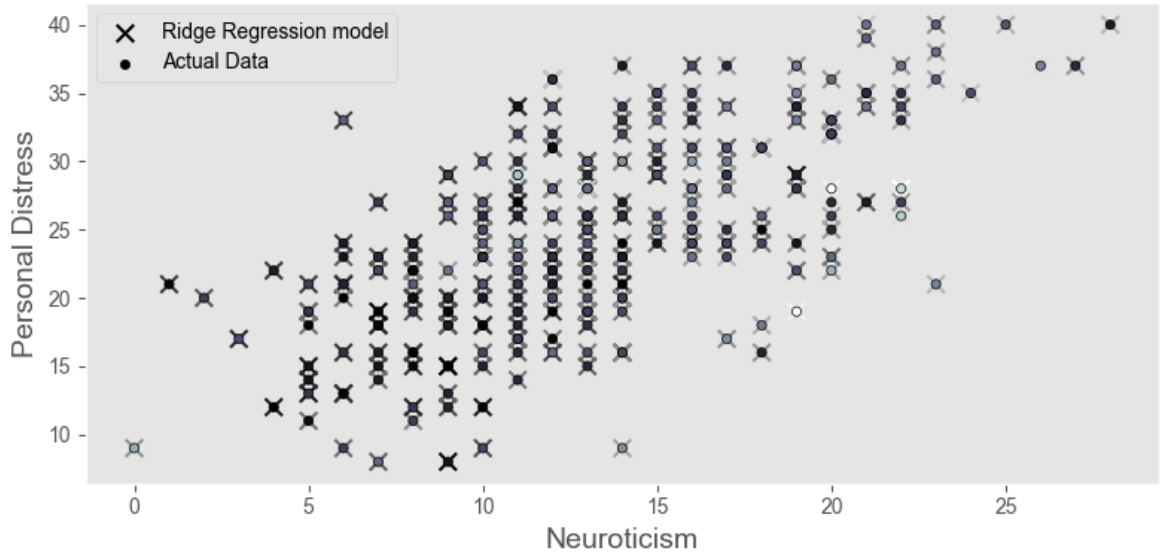

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Figure 3:

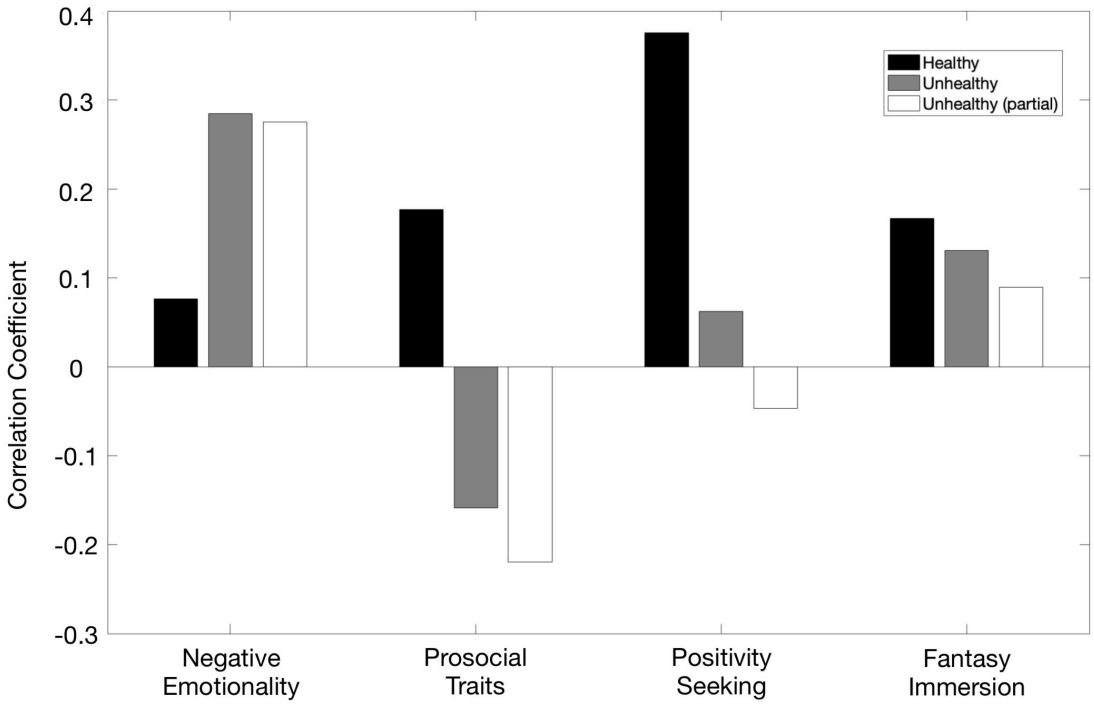

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Figure 4:

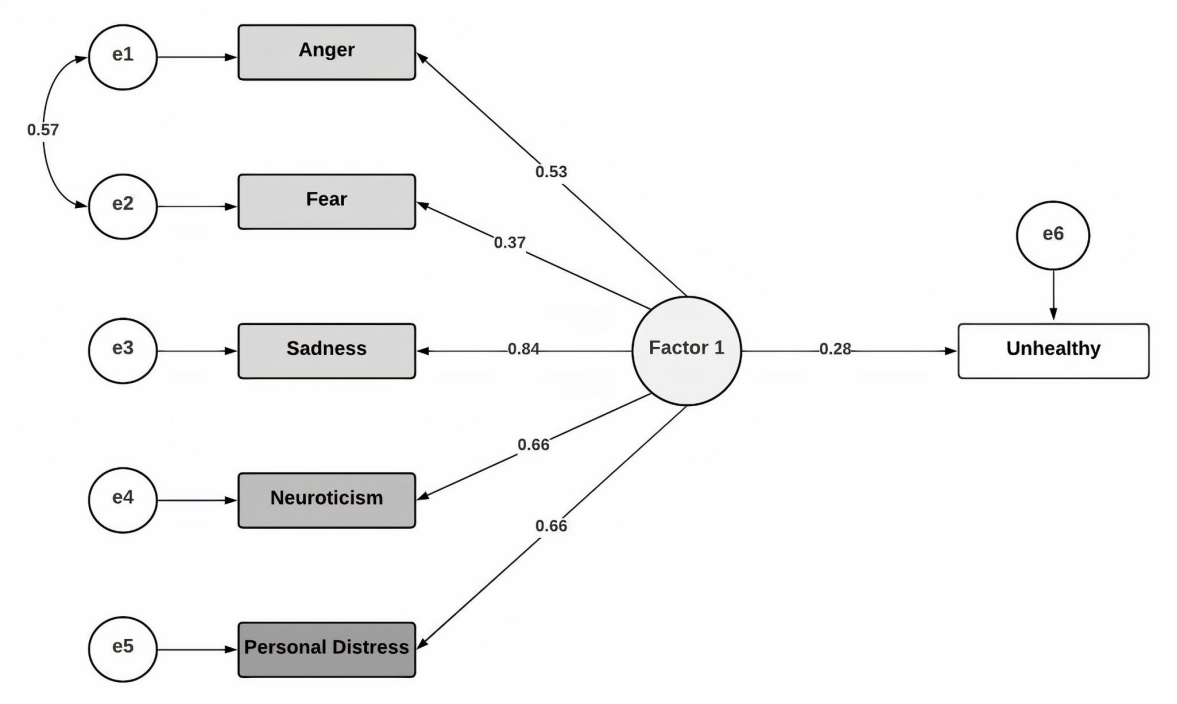

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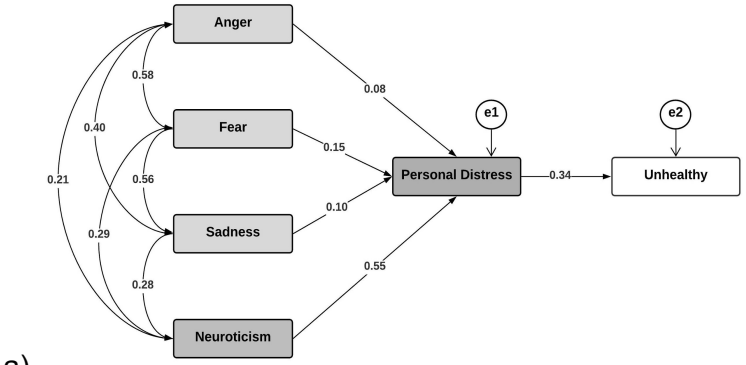
Figure 5:



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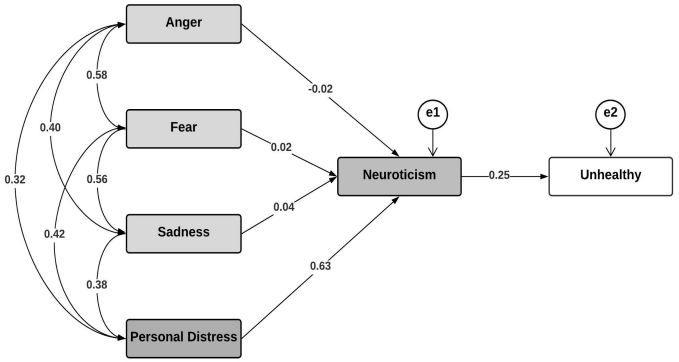

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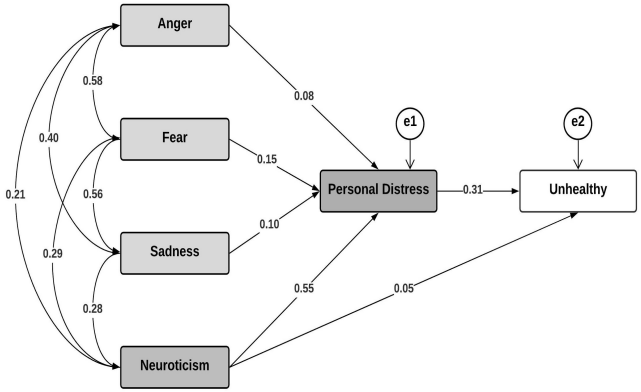

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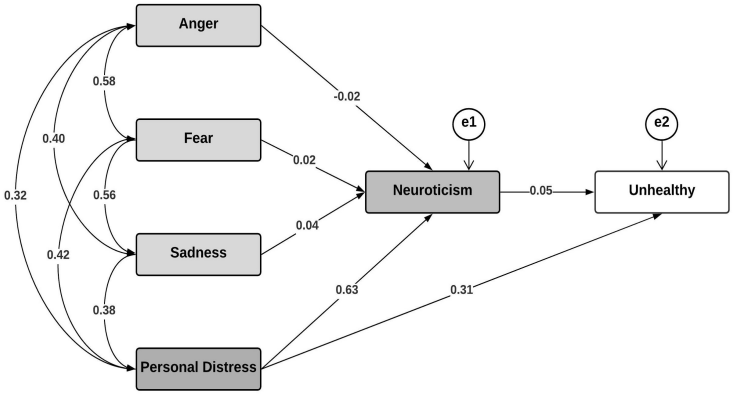

d)