

# Role of Sensory Processing Sensitivity in driving Maladaptive Music Use

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## Abstract

Sensory processing sensitivity (SPS), a trait marked by heightened reactivity to stimuli, is linked to emotional dysregulation and stress-related problems. Its subscales include Ease of Excitation that reflects emotional sensitivity to internal and external demands, Low Sensory Threshold reflects sensory overload susceptibility, and Aesthetic Sensitivity denotes appreciation for subtleties. While music can sometimes amplify maladaptive outcomes (rumination, avoidance), SPS's role in such behaviours, especially in non-Western contexts, remains underexplored. This study examines how SPS drives maladaptive music listening in 673 Indian adults. Network analysis and structural equation modelling revealed sensitivity to external demands elevated psychological distress which in turn predicted maladaptive music use. Reactivity to internal demands may reduce maladaptive music use but exacerbated it when mediated by external demands, reflecting preference for avoidant coping in Indian context. Findings emphasize SPS's role in maladaptive behaviours, demonstrating how sensory reactivity interacts with traits to shape distress-driven music use as an emotional regulation mechanism.

**Keywords:** Sensory Processing Sensitivity; Music Listening; Distress; Emotion Regulation; Network Analysis.

## Introduction

Sensory processing sensitivity (SPS) is a trait marked by heightened processing and reactivity to environmental stimuli, both psychological and physiological (Aron & Aron, 1997). Initially studied as a one-dimensional construct, subsequent research decomposed it into three subscales: *Ease of Excitation* (EOE) that reflects emotional sensitivity to internal and external demands, *Low Sensory Threshold* (LST) to sensitivity to sensory arousal, and *Aesthetic Sensitivity* (AES) to awareness of subtleties (Pleuss et al., 2018; Smolewska et al., 2006). People who exhibit high levels of this trait are called Highly Sensitive Persons (HSPs). They tend to process information more deeply, are more empathetic than the average person and are highly socially skilled (McQuarrie, 2023). They also possess a better appreciation for the arts, such as music and literature, and may be more affected by it (Aron E.N, 2013).

Owing to their heightened susceptibility to environmental and psychological stimuli, HSPs often have trouble regulating their emotions in negative environments and are more likely to adopt coping strategies that involve rumination or avoidance (Liu & Tian, 2024). These behaviours often

exacerbate distress (Fernandes & Panwar 2024) and can lead to heightened anxiety (Greven et al., 2019). The sub-factors of SPS such as EOE and LST seem to be associated with higher risk of depression as well (Liss et al., 2005). A recent study on Indian population reports that HSPs show a strong preference for disengagement coping strategies such as avoidance and withdrawal to regulate their affective responses (Fernandes & Panwar 2024). Yet it remains unclear how HSPs exhibit emotion-regulation strategies. To add to this, HSPs also tend to be highly emotional and demonstrate higher empathy levels, both in terms of feelings of personal distress and perspective taking (McQuarrie et al., 2023; Acevedo et al., 2018; Greven et al., 2019; Grimen & Diseth, 2016). High levels of personal distress are also associated with maladaptive emotion regulation and poor mental health outcomes (Gustavson et al., 2021; Tan et al., 2024).

While trait theories offer a dispositional framework, they fail to account for how and when traits manifest in specific behaviours, as personality functions are dynamic and influenced by situational contexts (Epstein, 1994; Mischel & Shoda, 1998). Thus, traits like SPS require contextualization to explain proximal causes of behaviour. Music listening can serve as a framework for understanding the behavioural role of SPS by providing specific motives and observing its dynamics.

Music is a part of everyday life and its affordances shape individuals' capacity for self-regulation and emotional well-being (DeNora, 2000; Laukka, 2007; Reybrouck, 2020). Music Engagement has beneficial effects on emotion regulation and well-being (Tan et al., 2024). Music-based interventions have also been employed for alleviating symptoms in clinical disorders (Gustavson et al., 2021; Chen, 2023). However, its effects on mental health are complex. While music can reduce stress and anxiety, elevate mood, and aid relaxation, maladaptive engagement, such as excessive reliance on music for avoidance (Miranda & Claes, 2009) or emotional numbing, can lead to negative psychological consequences. These include heightened anxiety and emotional dependency (Saarikallio et al., 2015; Garrido et al., 2017).

Studies have shown that individuals with ruminative tendencies may feel worse when listening to sad music while

in a negative emotional state (Larwood & Dingle, 2022; Garrido & Schubert, 2015). This may create a feedback loop, where maladaptive music use exacerbates emotional dysregulation rather than alleviating distress. The Healthy-Unhealthy Music Scale (HUMS) was developed as a tool to assess such maladaptive ways of musical engagement, which are often associated with a proneness to depression (Saarikallio et al., 2015). It consists of two subscales: *Healthy* assesses music use that relates to experiencing positive emotions, relaxation, and social connection; *Unhealthy* assesses the use of music for rumination, avoidance, and mood worsening. Cross cultural research has also suggested that *Unhealthy* music engagement is associated with negative emotionality and increased odds of experiencing depressive symptoms (Alluri et al., 2022; Kanagala et al., 2021).

Given that HSPs may sometimes resort to avoidance or withdrawal from highly stimulating environments to regulate their emotions (Aron et al., 2012, Fernandes & Panwar 2024), it remains to be seen whether Indian HSPs engage in maladaptive music listening (i.e., rumination and avoidance) to cope with emotional distress. In particular, HSPs with sensitivity to external and internal demands (EOE) may especially be vulnerable to using music maladaptively (Arora et al., 2023). Given India's collectivist culture which values interdependence and communal living, SPS linked behaviours in individuals may be more nuanced here as opposed to Western cultures. The present study focuses on the relationship between sensitivity to external and internal demands, maladaptive music listening, and distress levels in an Indian sample. To this end, we hypothesize sensitivity to external demands as a key driver of *Unhealthy* music use. We jointly investigate various measures of individual differences to observe the complex interplay among them and their relation to maladaptive music use.

## Methods

### Data Collection

680 individuals (mean age=20.69, std=1.9; 180 females) participated in exchange for monetary compensation. Ethical approval was obtained from the Institute Review Board, and all the participants provided Informed Consent with the option to withdraw at any time. Participants completed an online survey consisting of six standard questionnaires: 1. Highly Sensitive Person Scale (HSPS) measures the differences in SPS between individuals (Aron & Aron, 1997); 2. Kessler Psychological Distress Scale (K10), a 10-item questionnaire that measures anxiety and depression symptoms, assessing a person's emotional state over the past four weeks (Andrews & Slade, 2001); 3. Healthy Unhealthy Music Scale (HUMS) is a 13-item questionnaire that assesses music use patterns (Saarikallio et al., 2015); 4. Interpersonal Reactivity Index (IRI) assesses four facets of empathy on a

28-item questionnaire *Perspective Taking* (PT), *Fantasy Seeking* (FS), *Empathic Concern* (EC), and *Personal Distress* (PD). PT refers to the ability to see things from another individual's point of view; FS measures the tendency to be absorbed in fictional scenarios. EC is related to individual capacity for sympathy towards the affective state of others. Finally, PD relates to the feelings of personal distress in response to extreme distress in others (Davis, 1983); 5. Satisfaction with Life Scale (SWLS) which is a five-item scale measuring overall life satisfaction, rated on a seven-point Likert scale (Diener et al., 1985) and 6. Social Support Questionnaire (SSQ) which is a 27-item measure of perceived social support from family, friends, and significant others, rated on a six-point scale (Sarason et al., 1983).

### Data Analysis

We identified and removed outliers, using the Minimum Covariance Determinant (MCD) (Rousseeuw & Leroy, 1987). Given the non-normal high-dimensional nature of self-report psychological data, we performed outlier detection at different  $\alpha$  levels (0.05, 0.01, and 0.001). To capture the nuances of sensitivity traits in Indian context, we perform parallel analysis to identify the number of latent dimensions in the HSP scale. Subscales of HSPS were captured using Exploratory Factor Analysis (EFA) with varimax rotation. Item scores corresponding to each subscale from the questionnaires were aggregated. Internal consistency of the data was assessed using Cronbach alpha. Provided that we expect high correlation between independent variables (i.e., multicollinearity), we test sampling adequacy and homogeneity of variances using Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity, respectively. Then we identify broader socio-affective dimensions across sensitivity, empathy, psychological distress, social support, and life satisfaction using PCA with varimax rotation. Mean item complexity and Root Mean Square Residual (RMSR) suggest goodness of fit of our PCA model. Pearson correlations between these dimensions and *Healthy* and *Unhealthy* music use revealed high level relationships.

To observe the variables in a network composed of multiple interacting systems, a Regularized Partial Correlation Network (RPCN) was constructed using glasso regularization to estimate conditionally independent relationships while controlling for multicollinearity. For robust network analysis, data was transformed using non-paranormal transformation to near gaussian distribution. A regularization parameter ( $\lambda = 0.1$ ), for penalizing weak connections controlled for sparsity of the estimated network. To identify key nodes that strongly influence the network, permutation tests (1000 iterations) assessed significance of centrality and bridge indices. Network stability was evaluated via case-drop bootstrapping, confirming edge/strength

Table 1: Loadings of the measured variables on the four Principal Components.

Variable	K10	SWLS	IRI PD	Ext. EOE	LST	Int. EOE	IRI PT	AES	EC	SSQ SO	SSQ Family	SSQ Friends	IRI FS
PC1	<b>0.68</b>	<b>-0.61</b>	0.45	0.21	-0.11	0.11	-0.07	-0.32	0.12	-0.01	-0.27	-0.03	0.48
PC2	0.27	0.11	<b>0.62</b>	<b>0.81</b>	<b>0.78</b>	<b>0.76</b>	-0.04	0.4	0.05	0.05	0.07	-0.01	0.24
PC3	-0.1	0	-0.17	0.18	0.01	0.16	<b>0.76</b>	<b>0.66</b>	<b>0.74</b>	0.08	0.1	0.19	0.44
PC4	-0.26	0.47	0.14	0	-0.01	0.09	0.09	0.07	0.16	<b>0.81</b>	<b>0.71</b>	<b>0.83</b>	0.17

stability. Structure observed from network analysis provided empirical evidence to formally test the directional relationships and mediation effects among variables using Structural Equation Modelling (SEM). The beta coefficients ( $\beta$ ) indicated how much the dependent variable changes for a one-unit change in the independent variable, holding all other variables constant. This integrative approach ensured that PCA provided structure, RPCNs revealed network connectivity, and SEM validated the interactions between specified pathways. All statistical analyses were conducted in R.

## Results

### Descriptive Analysis

Outlier detection at different  $\alpha$  levels (0.05, 0.01, and 0.001) flagged the same seven participants out of 680, indicating that these cases were clearly distant from the main distribution, and therefore were excluded. Parallel analysis revealed an intrinsic dimensionality of four for items belonging to HSPS. EFA shows that these four factors accounted for 38.40% of the total variance. AES and LST retained their original item composition. While EOE was further sub-factored into: *Internal* EOE capturing sensitivity to Internal demands (e.g., "Being very hungry creates a strong reaction in me, disrupting my concentration or mood") and *External* EOE capturing sensitivity to external demands (e.g., "I get rattled when I have a lot to do in a short amount of time").

All variables demonstrate acceptable internal consistency results (Cronbach's  $\alpha > 0.75$ ). High multi-collinearity was observed between the variables. KMO value of 0.895 and Bartlett's test of sphericity ( $\chi^2 = 26602, p < .001$ ) confirmed the suitability of the data for PCA. The first four components explained 65% of the variance with a mean item complexity of 1.4 and RMSR of 0.07. The loadings of the first four components can be seen in Table 1. The first component was labelled as *Distress and Dissatisfaction* (PC1) as it had high loadings from K10 and high negative loadings from *Life Satisfaction* (SWLS). The second component was labelled *Sensory Reactivity* (PC2) as it was representative of *Ease of Excitation* (*External* and *Internal*), *Low Sensory Threshold* and moderately of PD (*Personal Distress*, for distinction see Methods). Third component was labelled as *Affective and*

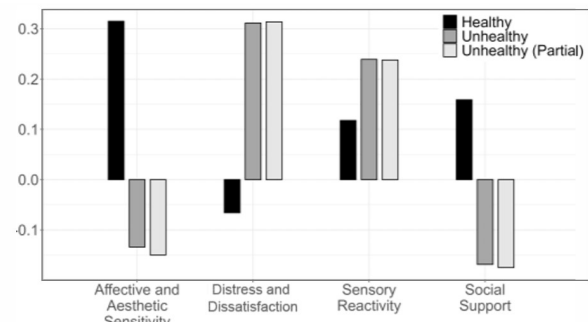


Figure 1: Correlations indicating independent contribution of *Unhealthy* music use to *Distress and Dissatisfaction* and *Sensory Reactivity*.

*Aesthetic Sensitivity* (PC3) and had high loadings from *Perspective Taking*, *Empathetic Concern*, and *Aesthetic Sensitivity*. The fourth component was labelled as *Social Support* (PC4) as it captured perceived social support and positively represented *Life Satisfaction*.

Figure 1 shows that *Unhealthy* use correlates strongly with *Distress and Dissatisfaction* ( $r = .56$ ) and *Sensory Reactivity* ( $r = .48$ ), but negatively with *Social Support* ( $r = -.32$ ) and *Affective and Aesthetic Sensitivity* ( $r = -.29$ ). Controlling for *Healthy* use, *Unhealthy-Distress and Dissatisfaction* semi-partial remains robust ( $\beta = .41$ ). *Healthy* music use is positively linked to dimensions of *Affective and Aesthetic Sensitivity* and *Social Support*.

### Regularized Partial Correlation Networks (RPCNs)

Figure 2 shows the resulting network visualizing relationships between sensitivity traits, distress, empathy, social support, and music use. *Healthy* music use was positively correlated with AES, the central node of the *Affective and Aesthetic Sensitivity* component while *Unhealthy* music use was linked with *Distress and Dissatisfaction* (K10, -SWLS) which in turn shares high closeness with *Sensory Reactivity* via PD. *Social Support* is observed to be a distinct sub-network with its components sharing small positive correlations with *Life Satisfaction*. Stability analysis demonstrated robustness: edge and strength stability coefficients (CS = 0.75) indicated the network retained 95% correlation accuracy even after dropping 75% of cases.

Table 2: Significant Network Measures; \* =  $p < 0.05$ .

Node	Betweenness	Bridge Betweenness
AES	72	71*
Ext. EOE	116*	53*
PD	112*	26
K10	118*	14
SWLS	88*	44*

Table 2 shows significant centrality and bridge measures. *External EOE* emerged as the most central node, appearing on shortest paths between nodes (Betweenness = 116) and bridging distinct groups of sensitivity traits and distress pathways (Bridge Betweenness = 53) also evident in Figure 2. AES also demonstrated high bridge betweenness (71) linking dimensions of *Sensory Reactivity* and *Affective and Aesthetic Sensitivity*. K10 (Betweenness = 118) and PD (Betweenness = 112) also can be seen as key mediators between components of *Sensory Reactivity* and *Distress and Dissatisfaction*. Network also shows *Social Support's* high intra-connectedness suggesting high betweenness of K10 and SWLS is partly due to its influence. Network centrality and bridge metrics identified *External EOE*, K10, and PD as critical mediators, guiding the structural equation model to formalize their direct and indirect pathways to maladaptive music use (*Unhealthy*).

### Structural Equation Modelling (SEM)

To explore individual variations in sensitivity to internal and external demands, we tested two models predicting *Unhealthy*. The models incorporated K10, *Personal Distress*, *External* and *Internal Ease of Excitation*, and SWLS, given its negative association with K10. We preserved the direct association between K10 and PD, based on the results from the network analysis. To delineate the effects of *Internal* and *External Ease of Excitation*, these measures were analysed independently. Model 1 specified direct and mediated effects of *External EOE* on *Unhealthy*, but only a direct effect of *Internal EOE*. Model estimation demonstrates that psychological distress (K10) is positively associated with PD ( $\beta = 0.219, p < 0.001$ ) and *External EOE* ( $\beta = 0.169, p < 0.001$ ), while associating negatively with Life Satisfaction ( $\beta = -0.378, p < 0.001$ ). Additionally, PD was treated as a secondary mediator on *External EOE* ( $\beta = 0.499, p < 0.001$ ). Finally, *Unhealthy* was regressed on psychological distress (K10) ( $\beta = 0.451, p < 0.001$ ), with a negative association with *Internal EOE* ( $\beta = -0.111, p < 0.05$ ) and a positive association with *External EOE* ( $\beta = 0.186, p < 0.001$ ). Model 2 tested if *External EOE* mediated the relationship between *Internal EOE* and *Unhealthy*. *Internal EOE* shows a negative direct effect ( $\beta = -.111$ ) but a positive indirect effect via *External EOE* ( $\beta = +.116$ ), leaving a near-zero total effect ( $\beta = .005$ ,

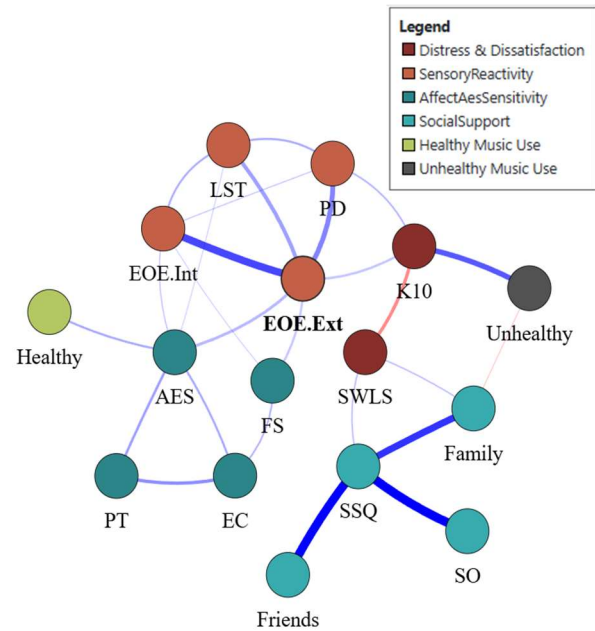


Figure 2: RPCN visualizing relationships between variables. Sensitivity to external demands (EOE.Ext) occupies the most central position in the network.

$p > .05$ ). Table 3 shows comparison of the two models. We evaluated their fit using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Model 1 showed a better fit (AIC = 5149.70; BIC = 5194.80) than Model 2 (AIC = 6727.70; BIC = 6781.90), suggesting that Model 1 provides a more parsimonious fit to the data.

### Discussion

SPS has been predominantly studied in western population and is linked with higher risk of mental health disorders such as depression and anxiety (Greven et al., 2019). There are limited studies that examine this trait with specific emotion regulation strategies via music listening. To our knowledge, this is the first study to investigate nuances of SPS in driving maladaptive music listening in a non-Western population, revealing differential sensitivity to internal and external demands via distress specific pathways. Our findings support the hypothesis that heightened sensitivity to external demands (*External Ease of Excitation*) exacerbates psychological distress, which in turn predicts maladaptive music use, characterized by rumination and avoidance. Methodologically, integrating network analysis with structural equation modelling we uncovered interactions often missed by traditional approaches, highlighting the value of combining dimensional and causal path frameworks.

PCA revealed that *Distress and Dissatisfaction* captured risks of anxiety and depression (K10) and low Life Satisfaction (SWLS), possibly with a tendency to experience distress and discomfort (PD) in response to non-conforming environments. *Sensory Reactivity* encompasses a susceptibility to being overwhelmed in overstimulating

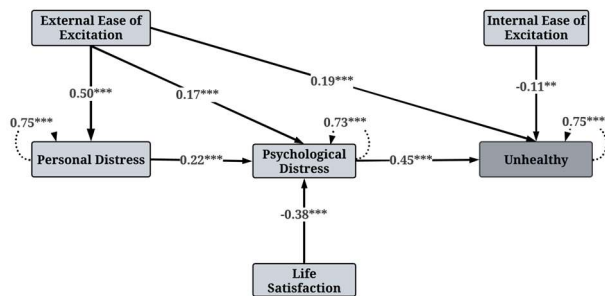


Figure 3: Path diagram of model 1 testing direct effects of sensitivity to internal and external demands on *Unhealthy* music use and other traits with psychological distress (K10) mediating all associations.

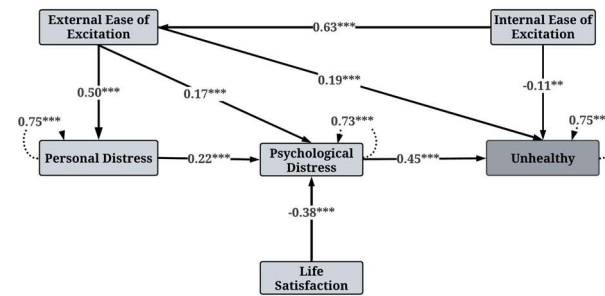


Figure 4: Path diagram of Model 2 testing similar pathways as model 1 with external EOE also mediating between internal EOE and *Unhealthy* music use.

environments (EOE, LST) and experiencing distress (PD). *Affective and Aesthetic Sensitivity* can be seen as a positive trait characterized by emotional awareness of subtleties that lets individuals attune to their environments in a healthy way. And lastly, the self-explanatory *Social Support* construct is also positively associated with an individual's satisfaction with life.

Among individual variables, *Unhealthy* music use correlated positively with *Distress and Dissatisfaction* and negatively with *Affective and Aesthetic Sensitivity* and *Social Support*. This is in line with previous research on non-Indian population (Choi et al. 2016, Salvarani et al. 2020, Alluri et al. 2022) suggesting that maladaptive music use is indeed linked to emotional dysregulation and heightened distress among individuals experiencing low empathy levels and social support. Significant correlation between *Healthy* and *Affective and Aesthetic Sensitivity* and *Social Support* suggests that it may be a marker for adaptive music listening strategies and well-being.

**Network Analysis and SEM**

RPCN identified *External EOE* as the central node, linking sensitivity traits with psychological distress (K10) via PD and highlighting that individuals sensitive towards external demands may be more prone to experiencing distress, a finding consistent with prior research (Smolewska et al. 2006; Brindle et al. 2015). K10 exhibited high node strength

with a strong association with *Unhealthy* music use, aligning with prior research on music-related rumination and its association with distress regulation (Garrido & Schubert, 2015). PD emerged as a central link between the sub-networks constituting *Sensory Reactivity* and *Distress and Dissatisfaction*, reinforcing its role in linking sensitivity traits to maladaptive outcomes. This may be due to its amplificatory effect in sensitive individuals who struggle to regulate distressing emotional experiences. AES exhibited strong centrality and a positive association with healthy music use. Additionally, its association with *Affective and Aesthetic Sensitivity*, together with EC and PT, suggests that AES facilitates adaptive emotion regulation, aligning with theories that aesthetic engagement may serve as a protective buffer against distress (Kuiken & Oliver 2013).

The SEM models proposed were based on centrality and bridging patterns inferred from network analysis. As a result, the models included external sensitivity as a key contributor to personal and psychological distress which in turn drives maladaptive music listening. SEM results (Figure 3 and 4) demonstrated that sensitivity to external demands indeed exerted significant direct and indirect effects on unhealthy music listening patterns. This aligns with prior literature, identifying unhealthy music listening as a coping mechanism to manage high negative emotionality (Alluri et al., 2022). Results also revealed the crucial role of psychological distress (K10) as a mediator between *Personal Distress*, *External EOE* and Life Satisfaction to maladaptive music

\* Table 3: Measures of fit indices for the SEM Models.

Model	Chi Square (df)	Chi Square / df	GFI	CFI	TLI	RMSEA	SRMR
Criteria based on Hooper et al. (2008)	n/a	<5.0	>.95	>.95	>.95	<.07	<.08
Model 2 (mediation)	15.944 (6)	2.6	0.99	0.989	0.975	0.05	0.024
Model 1 (simple)	15.374 (5)	3.1	0.986	0.983	0.959	0.056	0.023

\* Chi Square - Model chi-square, Chi Square/df - relative Chi Square, GFI - Goodness-of-fit statistic, CFI - Comparative fit index, TLI - Tucker-Lewis Index, RMSEA - Root mean square error of approximation, SRMR - standardised root mean square residuals

listening. This finding is supported by a previous study that identified a bidirectional relationship between *Unhealthy* music use and psychological distress (Kanagala et al., 2021). Both SEM models suggested that high sensitivity to internal demands (*Internal* EOE) is associated with reduced maladaptive music usage. However, Model 2 revealed that, indirectly, internal demands (*Internal* EOE) mediated by external demands (*External* EOE) resulted in increased maladaptive music usage. In a collectivistic society like India, individuals tend to prioritize managing external harmony over personal mood states. This amplifies the impact of external demands over internal demands on maladaptive music listening strategies. Thus, while internal demands alone did not significantly predict unhealthy listening, their combination with heightened external demands exacerbated both personal and psychological distress and, consequently, maladaptive music-listening patterns. These results support the hypothesis that *External* EOE plays a more substantial role than *Internal* EOE in driving maladaptive music use.

### Limitations & Future Work

Our methodological frameworks tested linear interactions between traits, mental health outcomes, and music use. They could benefit from non-linear modelling in the future. All constructs were assessed via self-report measures in participants. We recommend using multi-method assessments (e.g., listening history, longitudinal studies) in future.

### Conclusion

This study advances our understanding of how Sensory Processing Sensitivity (SPS) is associated with music use as an emotion regulation strategy in a collectivist culture. We factored SPS into four distinct traits and modelled its interactions with mental health indicators and music use. By combining network analysis with SEM, we demonstrate a two-stage approach for mapping trait-to-behaviour pathways in personality research. We identified high sensitivity to external demands as a key driver of distress-driven maladaptive music use. While sensitivity to internal demands alone may not contribute to maladaptive music listening, its interaction with external demands potentially leads to avoidant coping using music maladaptively.

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