## *Music and Addiction The development of Music Addiction Scale (MAS)*

HAMAKAWA, RYUICHI


## Department of Music


## MA Dissertation

# Music and Addiction

## The development of Music Addiction Scale (MAS)


**Z0157613**


**9/2021**


**Principal Supervisor: Tuomas Eerola**


9,400 words

# Abstract

Studies have reported cases of addictive dependency on musical behaviours. Although these investigated specific musical behaviours patterns, no instrument has been designed for a generic assessment of addictive music dependency. This study aims to develop a new instrument for assessing the addictiveness of generic engagement with music. This instrument, called Music Addiction Scale (MAS), is a comprehensive measurement instrument for detecting potential addictiveness and high engagement of generic engagement with music. Twenty-eight items in the MAS were adapted based on the literature and an online survey conducted with a sample with a range of cultural and national backgrounds. The structure of the MAS was investigated through exploratory factor analyses (EFA) and correlations between factors and other variables. The original MAS was revised to 20 items based on the results of these analyses. The trimmed MAS has ten items each for the addictive core criteria and engagement core criteria. Cronbach's alpha for the MAS was 0.93, and the concurrent of the addictive core criteria and the engagement core criteria was supported by loading scores to the factor structure and correlation scores to the addictive and high engagement phenomena. The MAS is a promising measurement instrument for assessing addictive dependency based on generic musical habits.

# Acknowledgements

The author sincerely thanks Tuomas Eerola for his scrupulous supervision throughout the presented research project. The author thanks Kelly Jakubowski for her supervision during the initial process of the presented research project. The author would not have been able to present the current study without the help of these inspiring scholars.

# Contents

# INTRODUCTION

Research in the field of music and science has long been exploring music's positive mechanisms and effects on emotion, perception, memory, and physical and mental wellness. Miendlarzewska and Trost (2014) suggest that music can enhance the development of brain functions including reading, writing, emotional intelligence, reasoning, and memorizing during the childhood learning period. In a study conducted by Sinclair et al. (2021), the impact of music on well-being was investigated from a holistic perspective. According to Sinclair et al., both the adolescent teenager group (AT) and older adult group (OA) showed improvements in physical, mental, intellectual, and social aspects of well-being through music as a resource. Additionally, positive evidence of the therapeutic value of music in addictive behaviours is suggested in a study by Blum et al. (2010). The power and the beauty of music seem to be limitless, and a good number of scholars have been revealing the secrets of music. However, few have turned their eyes to the negative side of music. Although music is unquestionably able to make one's life richer and more colorful, would there be any chances of negative influences from musical activities? In fact, the possibility of negative influence on physical or mental health caused by musical activities has been investigated as well. The mechanism of engagement with music has been gathering attention from researchers following the increasing reports of addiction-like dependency on musical behaviours such as excessive music practicing and loud-music listening (Ahrends, 2017; Schmuziger et al., 2012). These studies of addictive dependency on musical activities have suggested commonalities between patterns of musical behaviours and other behavioural addiction disorders.

Following the allocation of pathological gambling as the first behavioural addiction disorder listed in the latest Diagnostic and Statistical Manual of Mental Disorders (DSM-V, American Psychiatric Association, 2013), addictiveness in other activities has been confirmed (Atroszko et al., 2015; Brunborg et al., 2013; Leung et al., 2020; Robbins and Clark, 2015). Currently, the seven listings under the pathological gambling disorder section in DSM-V are addiction to internet gaming, internet, hypersexual, compulsive shopping, exercise, food, and UV (tanning). These behaviours have been identified as potentially addictive and may cause health issues. Studies have designed and tested measurement scales for each of the seven potentially addictive behaviours, and most of these measurement scales share a similar structural feature (Andreassen et al., 2015; Atroszko et al., 2015; Brunborg et al., 2013; Lee et al., 2018; Leung et al., 2020; Robbins and Clark, 2015). The structure shared by measurement scales for addictive behaviours is constructed based on the seven basic components of addiction developed and modified by Shytle et al. (1996), with wordings adapted from the diagnostic criteria for pathological gambling (American Psychiatric Association, 2013).

Although none of these seven behaviours has yet been officially listed in DSM as an independent disorder, some of them, such as internet gaming and compulsive shopping, are now generally known as addictive. Addictiveness has been studied and reported in other common daily activities, such as studying and smartphone social app use (Lee et al., 2018; Leung et al., 2020; Loscalzo et al., 2018).

A common question for behavioural addiction is "What exactly are the negative outcomes of these addictive behaviours?" The seven basic components of addiction defined by Shytle et al. (1996, p.1) state that "*The* '*addiction' builds on the combination of biological predisposition, social environment, and psychological constitution*", which indicates that social environment and psychological constitution can be the major components of behavioural addiction. This shared three components makes different behavioural addiction disorders more linkable to each other. If one is at risk of one behavioural addiction, then this individual also at higher risk for other addictions (Ford and Håkansson, 2020). According to Salman et al. (2012, p. 1), behavioural addiction can result in disorders such as

> "*anxiety, depression, obsessive thoughts, withdrawal and isolationism, affective disorders, disturbances in social relationships, school problems such as educational failure and lack of interest in doing homework, occupational or interpersonal difficulties, isolation and negligence of friends and family or personal responsibilities, and mental or physical restlessness. In instances when the individual reduces or stops a specific behaviour, excessive fatigue, lifestyle changes, significantly reduced physical activity, deprivation and changes in sleep patterns, impatience, sexual deviations, violence, eating disorder and withdrawal symptoms ensue*."

Avoiding or stopping the development of addictive dependency on a particular behaviour requires detecting the level of the addictiveness of that behaviour through a measurement instrument that assesses the social environment and psychological constitution of the behaviour. Researchers have developed measurement instruments for assessing the social environment and psychological constitution of behaviour based on the multi-components model developed by Shytle et al. (1996). The Bergen Shopping Addiction Scale (BSAS) developed by Andreassen et al. (2015) is one of the instruments that employ the multi-components model. The BSAS has seven dimensions: *salience, mood modification, conflict, tolerance, relapse, withdrawal,* and *problems.* Each dimension consists of four question items, so the scale has 28 items in total. A similar dimensional structure can be seen in a study by Charlton and Danforth (2007) on the distinction between addiction and high engagement with online game playing. The study developed a set of questions called the Addiction-Engagement Questionnaire, a 29-item instrument with seven dimensions: tolerance, euphoria, salience (cognitive), salience (behavioural), conflict, relapse, and withdrawal. The effectivity and validity of these instruments have been reported (Andreassen et al., 2015; Charlton and Danforth, 2007). Although biological analysis of behavioural addiction was also researched, a

study by Becirevic and colleagues (2017) investigated addictive dependency on indoor tanning, severity, and behavioural addiction for indoor tanning. The study suggests that the penetration of ultraviolet (UV) light emitted by indoor tanning into the skin stimulates the release of endogenous opioids, which explains the addictiveness of indoor tanning biologically. However, biological predisposition in the case of behavioural addiction is thought to be less relevant compared to substance addiction. Thus, it is usually assessed independently from the other two major components of behaviour addiction.

## Potential music-induced harm

The present study concerns possible addictive dependency on music that could eventually lead to physical or mental issues. Silverman and colleagues (2020) conducted a study on music-induced harm (MIH), defining it as a music-evoked multifaceted and maladaptive construct wherein a person experiences diminished health or well-being. The concept of MIH is highly relatable to the addictive dependency on music introduced in the present study. Silverman et al. (2020) hypothesized that types of MIH vary depending on the deliverer, music, recipient, and context. A study by Eerola et al. (2012) reports that sad music can induce not only sadness but also positive emotions. Thus, people enjoy sad music despite its induced negative emotion. On the other hand, Peltola and Eerola (2016) repot that some sad music experiences relate to truly negative emotions (grief, feelings of loss, etc.) despite of their enjoyable melodies. The study also reports that scary music was perceived as significantly unpleasant due to the lack of aesthetic appeal in the music itself. The scary music in this case would be the MIH to the recipient. Short and Dingle (2016) reported another example of MIH, in which music may work as a mild auditory cue for emotions and cravings in adults with substance use disorders. This indicates that music and music preferences can be linked with other behaviours cognitively and functioning as an MIH as the result. Additionally, following the exploration in the area of music and health, scholars such as McFerran et al. (2016) and Chin and Rickard (2014) have studied the underlying effect of music on well-being. McFerran et al. (2016) conducted an interpretive review of 33 studies published between 2000 and 2012 investigating the relationships between music and mental health of youth population. The review reported that certain types of music may cause negative mental or physical issues. For instance, musical behaviour of “rapping” is associated with depression and mood disorders, and “worshipping” is associated with negative self-perception (McFerran et al., 2016). Although the review also shows that listeners may perceive positive effects from “rapping” such as feelings of empowerment and modified mood, the potential negative impacts on mental wellness are what to be concerned. While McFerran and colleagues have investigated the relationship between music and well-being focusing on the music types, Chin and Rickard (2014) focused on involved aspects of engagement with music. Chin and Rickard (2014) reported that:

> *"Engaging with music for the purpose of cognitive and emotion regulation may enhance well-being primarily through the habitual use of cognitive reappraisal. In contrast, various other aspects of music engagement (music listening, engaged production, and social connection) if coupled with a tendency to regulate emotions and thoughts by expressive suppression may yield undesirable well-being outcomes.*"

This suggests that the relationship between the use of music and aspects (purpose or motivation) of engagement with music can be one of the key factors that decide the quality of the outcome of the use of music.

Such cases of MIH have been reported in studies on the addictiveness of specific musical activities. Investigations of specific musical behaviours have shown shared commonalities between music activities and behavioural addiction disorders. According to a study conducted by Schmuziger et al. (2012), addictive-like behaviour towards loud music was confirmed among those who have self-exposed to loud music for a significant amount of time. Seven of the 50 non-professional pop and rock musicians showed evidence of maladaptive music listening behaviours, while none of the 50 matched control group did. However, this study focuses on the connection between listening to loud music with a background factor of an extended period of self-exposure to loud music. Thus, the mechanism and the reason for the extended period of self-exposure to loud music were not investigated. Because the reported result of those who have developed addictive-like behaviours toward loud music was caused by a maladaptive use of music (a long term of self-exposure to loud music), the musical activity can be labelled as an MIH produced within an addictive dependency on music. Another MIH produced by addictiveness in musical activity has been identified in excessive music practicing (Ahrends, 2017). Ahrends aimed to study whether a maladaptive behaviour exists in music practicing and if this behaviour is or is not likely to lead to addictive behaviours in music practice. This study reports that three out of 25 musicians who participated were classified as "at risk for dependence", and 20 others showed a partly maladaptive behaviour pattern in practice. While the small size of the sample of the study leaves some room for interpretation in its prevalence and reliability, music practice shares commonalities in the meaningful factors that describe the addictive phenomenon of clinical behavioural addiction disorders.

Studies have reported and suggested multiple occasions when music can negatively affect physical or mental wellness. It can grow into an addictive dependency based on factors such as duration, music types, method, and the listener's state. However, no measurement instrument has yet been developed for assessing possible addictive dependency on music from a wider view. Existing data and reports in related fields currently concentrate on specific musical activities, but no instrument that assesses musical habits based on a comprehensive interview has been designed. One possible explanation for this situation is that music has become closer than ever to people's everyday lives, thanks to recent technological

developments and life quality improvement. Musical activities are much easier to access today, which means the level of the potential effect of music on people grows at the same time. The results of these studies indicate that more cases of addictive-like behaviour with musical activities may appear in the future. Therefore, the mechanism and consequences of the development of addictive dependency on musical activities must be studied to avoid negative outcomes from enjoying music in the wrong way. Based on the effectivity shown for other addictive behaviours such as shopping (Andreassen et al., 2015) and gaming (Charlton and Danforth, 2007), addictive phenomena in musical activities may be assessable with dimensional criteria of clinical diagnoses for behavioural addictions. However, as Saarikallio comments, "*The health-relevance of music cannot be defined by a single musical activity or a particular genre preference but needs to be considered within a broader context of the individual*" (Saarikallio et al., 2015, p. 211). A new measurement instrument that focuses on detecting the underlying tendency and proneness to develop an addictive dependency on general music habits is required before a comprehensive investigation of addictiveness in music is possible.

## AIMS

The present study aims to develop a measurement scale, the Music Addiction Scale (MAS), for assessing the addictiveness of general music listening habits by differentiating addictive dependency from engagement with musical activities. The MAS was adapted from the existing Bergen Shopping Addiction Scale developed by Andreassen et al. (2015). Compared to other behaviourally addictive activities such as compulsive shopping and video gaming, one difficulty of assessing addictiveness in music is distinguishing between high engagement with music and addictive dependency on music. Thereby, a psychometric instrument for assessing healthy and unhealthy consumption of music (HUMS) developed by Saarikallio et al. (2015) was employed in the current study to assess the functionality of the MAS in differentiating addictive dependency from engagement with music. To investigate the connection between musical sophistication background and proneness for developing an addictive dependency on music, the active engagement (AE) and musical training (MT) facets of the Goldsmith Musical Sophistication Index (Gold-MSI) (Müllensiefen et al., 2013) were included in the survey.

## METHODS

### Participant recruitment and sampling

A total of 295 participants were recruited from major social media platforms such as Facebook and LinkedIn. The recruited participants were informed they would be participating in a survey studying the influence of music use. Specific words such as 'addiction' and

information that could lead to forming pre-bias to the survey results were not mentioned during the initial recruitment. All the participants were told about the specific topic of the study at the end of the survey. A total of 249 effective responses were recorded (N=249, 42.2% male, 56.6% female, 1.2% prefer not to say). The mean age of the subject group was 27.9 (SD=9.1 years), and the age ranged from 18 to 60 years. The range of 20 participant nationalities and native languages was broad; the majority of participants were from China (N = 60: 24.1%), Japan (N = 42: 16.9%), the United States of America (N = 32:12.9%), South Africa (N = 32:12.9%), and the United Kingdom (N = 11:4.5%), with a small number (N<10) from each of the other countries (N = 69: 27.7%). Three participants preferred not to give their nationality. Participation in the study was completely voluntary and anonymous, and no incentive in any form was involved, nor any monetary compensation. Informed consent for the survey was obtained from every participant, and the ethics approval was secured from the host institution.

## Survey procedure

All three measurement scales (MAS, HUMS, Gold-MSI) and basic demographic questions were integrated into an online questionnaire survey via the online survey platform Qualtrics. The questionnaire consisted of four sections with 64 items in total. The first section of the survey included a consent form and basic demographic information questions. The online survey was conducted with participants over 18 years old and fluent enough in English to understand every question of the survey. The survey only required elementary-level English to be understood, so no responders were excluded due to a lack of fluency in English. Only those who provided their informed consent to the current study were instructed to continue the survey. The second section of the survey comprised the MAS (28 items), the third section comprised the HUMS (13 items), and the last section comprised the Gold-MSI (16 items). Following the original scoring of the HUMS and the Gold-MSI, the HUMS employs a 5-point Likert scale (*1=Never, 2=Almost never, 3=Sometimes, 4=Often, 5=Always*), and the Gold-MSI employs a 7-point Likert scale (*1=Completely disagree, 2=Strongly disagree, 3=Disagree, 4=Neither agree nor disagree, 5=Agree, 6=Strongly agree, 7=Completely agree*). Every item of the questionnaire was provided with an extra choice of "prefer not to say." Every item of the questionnaire except the first section and the last question (Gold-MSI MT07, "Music is like an addiction to me") was randomized within each section.

## Music Addiction Scale (MAS)

The initial version of the Music Addiction Scale (MAS) was formulated based on the Bergen Shopping Addiction Scale developed by Andreassen et al. (2015). Four items were constructed for each of the seven dimensions (28 items in total) to consider the following characteristic features: moods, motivations, social interactions, self-regulation, and identities (see Table 1). The seven-dimensional structure and wordings were inspired by and adapted from the Bergen Shopping Addiction Scale and the DSM-V pathological gambling criteria (American Psychiatric Association, 2013). The scoring scale of the MAS employs a 7-point Likert scale (*1=Completely disagree, 2=Strongly disagree, 3=Disagree, 4=Neither agree nor disagree, 5=Agree, 6=Strongly agree, 7=Completely agree*).

Per Charlton and Danforth (2007), the relapse, withdrawal, conflict, and problems dimensions are categorized as addiction core criteria, and the salience, tolerance, and mood modifications dimensions are categorized as engagement core criteria (see Table 2). However, some items are expected to correlate similarly to both the addictive core criteria and the engagement core criteria. This is because in the case of music items such as mas05 "*I listen to music to feel better (relieve stress)"* and mas22 "*I become sour and grumpy if for some reason I cannot listen to music when I feel like it"* can be applied to both engagement and addictiveness. Accordingly, the initial 28-item version MAS will be modified, and question items with high cross-loadings (0.30<) will be trimmed off based on the result of an exploratory factor analysis (EFA). Considering that engagement in music is an essential condition for developing an addictive dependency on musical activities, the ideal function of the MAS is to separate those who are developing an addictive dependency from those who are already engaged with music. Therefore, items of the addictive core criteria need to be referring to addictiveness more than to engagement: an example can be mas25 "*I listen to music so much that it has caused physical or health problems.*" The detailed process of the examination by which MAS items were trimmed from the original 28-item MAS is reported in the statistical analysis section below.

To assess whether any participants would be identified as addicted or highly engaged, three groups are identified based on the responses on the trimmed MAS (N = 249). The responders who scored high (>4.0) in the trimmed engagement core criteria are labelled as the engaged group (N=54: 21.69%). Those who scored high (>4.0) in the trimmed addictive core criteria were labelled as the addicted group (N = 9: 3.61%). In addition, the present study investigates the addictive dependency further by performing one-way ANOVA analyses to study how addictive dependency would impact responder's performance of the other two measurement scales (HUMS and Gold MSI). Responders who score below 33% in the trimmed MAS addictive criteria are labeled as low addictive, responders who score above 33% but below 66% are labeled as medium addictive, and those who score above 66% are labeled as high addictive for the one-way ANOVA analyses.

Table 1. Seven components for each dimension of the Music Addiction Scale

| | |
|---|---|
| *Salience* | • Listening to music becomes the most important and dominant activity in a person's life. Dominance is both mental (thinking) and physical (lifestyle). |
| *Tolerance* | • The minimum requirements of music listening behaviours to maintain mental or physical peace are rising. Someone starts listening to music more often, thereby gradually building up the amount of time spent listening to music. |
| *Mood modification* | • The subjective emotional reactions that people report as a result of engagement in daily music listening: mood modification includes not only emotions directly perceived from the music, such as happiness or sadness, but also emotions experienced, such as calming. |
| *Withdrawal* | • Unpleasant emotions and/or physical effects occur when music listening activity is disturbed or discontinued: withdrawal consists mostly of moodiness and irritability but may include physiological symptoms, such as shaking (Robbins, T. et al., 2015). |
| *Relapse* | • Continued listening to music is quickly restored after periods of abstinence or control. |
| *Conflict* | • This refers to interpersonal conflicts resulting from music listening. Conflicts may occur between the listener and those around him/her, such as frequent arguments and disagreements over the listener's music listening activity. |
| *Problems* | • Physiological and/or psychological wellness issues caused by the listener's music listening: this refers to displacement problems as the object of addiction takes precedence over activities such as school, work, and socializing. Problems may arise within the individual, such as interpersonal conflicts and subjective feelings of loss of control. |

Table 2. Initial pool items for the Music Addiction Scale

| No. | Dimension | Item text |
|---|---|---|
| 1 | Salience | Music/listening to music is the most important thing in my life. |
| 2 | Salience | When I'm not listening to music, I think about it all the time. |
| 3 | Salience | I spend a lot of time thinking about or planning what music to listen to. |
| 4 | Salience | Thoughts about music/listening to music keep popping into my mind. |
| 5 | Tolerance | I listen to music to feel better (relieve stress). |
| 6 | Tolerance | I listen to music to feel good (gain pleasure). |
| 7 | Tolerance | I listen to music to forget my personal problems. |
| 8 | Tolerance | I listen to music to reduce feelings of guilt, anxiety, helplessness, loneliness and/or depression. |

| No. | Dimension | Item text |
|---|---|---|
| 9 | Mood modification | I feel an increasing inclination to spend time listening to music. |
| 10 | Mood modification | I spend much more time listening to music than I had intended/planned. |
| 11 | Mood modification | I feel I need to listen to music constantly to obtain the same mental satisfaction as before. |
| 12 | Mood modification | I spend more and more time listening to music. |
| 13 | Withdrawal | I listen to music so much that it negatively affects my daily obligations (e.g., school or work). |
| 14 | Withdrawal | I give less priority to my daily obligations because of listening to music. |
| 15 | Withdrawal | I have ignored love partners, family and friends, because I would rather listen to music. |
| 16 | Withdrawal | I often end up in arguments with others because of music or listening to music. |
| 17 | Relapse | I have tried to cut down the amount of time I spend listening to music. |
| 18 | Relapse | I have been told by others to reduce the amount of time I spend listening to music but have not been able to take their advice. |
| 19 | Relapse | I have decided to spend less time listening to music but have not been able to do so. |
| 20 | Relapse | I have managed to limit the time I spend listening to music for periods and then experienced a relapse. |
| 21 | Conflict | I become stressed if I am prevented from listening to music. |
| 22 | Conflict | I become sour and grumpy if for some reason I cannot listen to music when I feel like it. |
| 23 | Conflict | I feel bad if for some reason I am prevented from listening to music. |
| 24 | Conflict | If it has been a while since I last listened to music, I feel a strong urge to listen to music. |
| 25 | Problem | I listen to music so much that it has caused physical or health problems. |
| 26 | Problem | I listen to music so much that it has impaired my well-being. |
| 27 | Problem | I have felt the urge to listen to music so strong that it sometimes has made me sleepless. |
| 28 | Problem | I have been bothered by a bad conscience because of listening to music. |

*Subjects were instructed to choose from the following choices: 1=Never, 2=Almost never, 3=Sometimes, 4=Often, 5=Always

## Healthy and Unhealthy Music Scale (HUMS)

This measurement scale comprises 13 items that can be divided into a healthy subscale and an unhealthy subscale. The healthy subscale (HUMS healthy) consists of five items and the unhealthy subscale (HUMS unhealthy) consists of eight items. The HUMS was originally developed and validated for assessing proneness for depression in youth with musical

engagement as an indicator (Saarikallio, Gold & McFerran, 2015). This measurement instrument is employed to support the development of the MAS by examining whether the addictive group also scores higher in HUMS unhealthy items compared to the highly engaged group.

### Goldsmith Musical Sophistication Index (Gold-MSI).

This 16-item scale comprises two facets of the Goldsmith Musical Sophistication Index (Müllensiefen et al., 2013), the active engagement facet (AE) and the musical training facet (MT). The Gold-MSI scale in the current study consists of nine AE items and seven MT items, and the scale was scored and analyzed following the original operation by Müllensiefen et al. (2013). The Gold-MSI, specifically the AE and MT facets, was employed in the development of the MAS to explore the relationship between musical sophistication background and other variables studied. Correlation between the two AE and MT facets and other variables was examined to study whether sophistication background contributes to a person's engagement in or addictive dependency on music.

## Statistical analysis

Statistical analysis in the present study includes descriptive analysis, comparison of means, exploratory factor analysis (EFA) and correlational analysis. Descriptive statistics including frequencies, central tendency, variability, and Cronbach alphas of the studied variables were calculated. Analysis of variance (ANOVA) was conducted to see how the MAS and other items were scored between the four participant groups. The EFA (principal axis factoring) was conducted to capture the factor structure and identify the underlying factors of the MAS, which is required for constructing a revised version of MAS. A one-way ANOVA analysis was conducted on the factor structure over age and gender.

Two correlational analyses were conducted in the current study. The first correlational analysis was conducted on the following study variables: Factors 1 and 2 (F1 and F2) generated by the second EFA, trimmed MAS addictive core, trimmed MAS engagement core, HUMS healthy, HUMS unhealthy, Gold-MSI AE, and Gold-MSI MT. The factors (F1, F2) generated by the second EFA were estimated based on how they correlate to the two trimmed MAS core criteria and the two HUMS subscales. The second correlational analysis was conducted on the seven dimensions and the two core criteria of the original 28-item MAS: addictive core, engagement core, salience, mood modification, tolerance, conflict, relapse, withdrawal, and problems. Two hypotheses are made here, and the first one is that the MAS addictive core criteria would correlate to HUMS unhealthy subscale positively. The second hypothesis is that the MAS engagement core criteria would correlate to HUMS healthy subscale positively.

# RESULTS

## Descriptive

Table 3 presents mean scores and standard deviations for all the MAS items. On average, participants scored high in the engagement core criteria of the MAS: salience (N=249, M=3.36, SD=1.21), tolerance (N=249, M=3.48, SD=1.27), and mood modification (N=249, M=4.78, SD=1.09). Although the overall mean scores of the addictive core criteria were lower than the engagement core criteria, the mean score of the withdrawal dimension (N=249, M=3.57, SD=1.31) was significantly higher than other dimensions of the addictive core criteria: conflict (N=249, M=2.11, SD=1.00), relapse (N=249, M=2.40, SD=1.11), and problems (N=249, M=2.22, SD=1.01). The MAS item with the highest mean score is mas05 (N=249, M=5.50, SD=1.18) "I listen to music to feel better (relieve stress)," and the item with the lowest mean score is mas25 (N=249, M=1.73, SD=1.16) "I listen to music so much that it has caused physical or health problems."

Table 3. Mean scores and standard deviations for MAS items

| | Item | M | SD | | Item | M | SD |
|---|---|---|---|---|---|---|---|
| Salience | mas01 | 3.30 | 1.67 | Withdrawal | mas15* | 2.22 | 1.44 |
| | mas02* | 2.92 | 1.47 | | mas16 | 2.24 | 1.39 |
| | mas03* | 3.28 | 1.55 | Relapse | mas17 | 2.42 | 1.26 |
| | mas04 | 3.97 | 1.60 | | mas18 | 2.14 | 1.39 |
| Tolerance | mas05 | 5.50 | 1.18 | | mas19 | 2.39 | 1.31 |
| | mas06 | 5.49 | 1.20 | | mas20 | 2.70 | 1.49 |
| | mas07 | 3.67 | 1.67 | Conflict | mas21 | 3.11 | 1.51 |
| | mas08 | 4.46 | 1.64 | | mas22* | 3.19 | 1.56 |
| Mood modification | mas09 | 3.63 | 1.54 | | mas23 | 3.69 | 1.68 |
| | mas10* | 3.37 | 1.75 | | mas24 | 4.33 | 1.79 |

Table 3. Mean scores and standard deviations for MAS items

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | mas11* | 3.30 | 1.62 | Problems | mas25 | 1.73 | 1.06 |
| | mas12* | 3.64 | 1.61 | | mas26 | 2.25 | 1.48 |
| Withdrawal | mas13 | 1.95 | 1.21 | | mas27* | 2.54 | 1.57 |
| | mas14 | 2.08 | 1.18 | | mas28 | 2.37 | 1.28 |

*Removed from the revised version of the MAS (high cross-loading).

Out of 249 effective responders, 9 responders scored averagely higher than 4.0 in the trimmed addictive core criteria and were categorized as addicted group, 54 responders scored averagely higher than 4.0 in the trimmed engagement core criteria and were categorized as the engaged group, and the rest were categorized as the ordinary group (N=186). Table 4 presents the means and standard deviations of HUMS scores and Gold-MSI scores between the three subject groups (see Table 4). To further study the impact of addictive dependency in music activity, one-way ANOVA analyses were performed to compare the effect of addictive dependency in music activity on each of the HUMS unhealthy, HUMS healthy, Gold-MSI AE and Gold-MSI MT between low addictive group (<33% quantile), medium addictive group (between 33% and 66% quantile), and high addictive group (above 66% quantile). These three groups are arbitrarily assigned according to three quantiles but the aim of this is to explore broadly how a balanced division of scores in addictive dependency are related to other variables.

For the HUMS unhealthy score, a one-way ANOVA analysis revealed that there were statistically significant differences at the $p<.001$ level between all three addictive level groups ($F[2,240]=34.59$, $p<.001$). Post hoc comparisons using the Turkey's HSD test for multiple comparisons found that the mean value of HUMS unhealthy score was significantly different between low addictive group and medium addictive group ($t(240)=-4.19$, $p=.0001$). Post hoc analysis of the HUMS unhealthy score between medium addictive group and high addictive group suggested a statistically significant difference ($t(240)=-4.24$, $p=.0001$). Post hoc analysis of the mean value of HUMS unhealthy score between low addictive group and high addictive group also found a statistically significant difference ($t(240)=-8.32$, $p<.0001$). For the HUMS healthy score, a one-way ANOVA analysis revealed that there was a statistically significant difference at the $p<.001$ level between low addictive group and medium addictive group, but no statistically significant difference was found between medium addictive group

and high addictive group ($F$[2,240]=10.83, $p$<.001). Post hoc comparisons using the Turkey's HSD test for multiple comparisons found that the mean value of HUMS healthy score was significantly different between low addictive group and medium addictive group ($t$(240)=-3.83, $p$=.0005). Post hoc analysis of the HUMS healthy score between medium addictive group and high addictive group suggested no statistically significant difference ($t$(240)=-.43, $p$=.91). Post hoc analysis of the mean value of HUMS healthy score between low addictive group and high addictive group found a statistically significant difference ($t$(240)=-4.19, $p$<.0001).

For the Gold-MSI AE facet score, a one-way ANOVA analysis revealed that there was a statistically significant difference at the $p$<.001 level between low addictive group and medium addictive group, but no statistically significant difference was found between medium addictive group and high addictive group ($F$[2,240]=19.66, $p$<.001). Post hoc comparisons using the Turkey's HSD test for multiple comparisons found that the mean value of Gold-MSI AE score was significantly different between low addictive group and medium addictive group ($t$(240)=-5.66, $p$<.0001). Post hoc analysis of the Gold-MSI AE score between medium addictive group and high addictive group suggested no statistically significant difference ($t$(240)=.41, $p$=.91). Post hoc analysis of the mean value of Gold-MSI AE score between low addictive group and high addictive group found a statistically significant difference ($t$(240)=-5.16, $p$<.0001). For the Gold-MSI MT facet score, a one-way ANOVA analysis revealed that there was no statistically significant difference between all three addictive level groups ($F$[2,240]=.22, $p$=.803).

Table 4. Means and standard deviations of HUMS and Gold-MSI between the identified subject groups

| | N | HUMS Unhealthy | HUMS Healthy | Gold-MSI AE | Gold-MSI MT |
|---|---|---|---|---|---|
| Scoring scales | | *1=Never, 2=Almost never, 3=Sometimes, 4=Often, 5=Always* | | *1=Completely disagree, 2=Strongly disagree, 3=Disagree, 4=Neither agree nor disagree, 5=Agree, 6=Strongly agree, 7=Completely agree* | |
| Addicted | 9 | M=3.28, SD=0.46 | M=4.24, SD=0.47 | M=6.03, SD=0.83 | M=3.73, SD=1.83 |
| Engaged | 54 | M=2.29, SD=0.66 | M=4.50, SD=0.46 | M=5.50, SD=1.09 | M=3.44, SD=1.68 |
| Ordinary | 186 | M=1.87, SD=0.56 | M=3.84, SD=0.64 | M=4.24, SD=1.26 | M=3.15, SD=1.50 |

## Factor analysis

Two EFAs were conducted in R, version 1.4.1103. The first EFA was performed on the original 28-item MAS model. It had an adequate fit in the effective responses sample (KMO all: 0.935, minimum item:0.861, maximum item:0.962). The first EFA suggested two factors that explained 43.8 per cent of the total variance (F1-N=18, min=0.374, max=0.713 proportion of variance=22.1%. F2-N=19, min=0.466, max=0.753, proportion explained=21.7%). Eight cross-loadings (0.30<) were detected from the first EFA. To capture a clear internal factor structure of the MAS, high cross-loading (0.30<) items were trimmed from the original 28-item MAS for further analyses. These eight items were removed from the MAS for the second EFA that was performed on the trimmed MAS (KMO all: 0.911, minimum item:0.844, maximum item:0.938). The second EFA suggested two factors (F1-N=10, min=0.314, max=0.758, proportion explained=24.8%. F2-N=10, min=0.516, max=709, proportion explained=19.9%) as did the first EFA. Additionally, the structure of loading items to each factor matched that of the first EFA, which indicated that both the first and the second EFA captured the same factor structure within the MAS. Based on the structure of loading items to each factor of the second EFA, the F1 was defined as the *addictive factor* and the F2 was defined as the *engagement factor*. The original 28-item MAS was trimmed to a revised version with 20 items (see Table 5).

An ANOVA analysis of F1 and F2 across genders and age was conducted to see if any variables make a significant difference in loading to F1 and F2. The ANOVA test on F1 over age ($F[1,193]=0.093$, $p <.761$) and gender ($F[2,193]=1.615$, $p <.202$) suggested no significant differences in loading to F1. The ANOVA test on F2 over age ($F[1,193]=5.861$, $p <.05$) suggested a significant difference in loading to F2, but gender ($F[2,193]=0.364$, $p <.695$) suggested no significant differences.

Table 5. Revised MAS (8 items with high cross-loading were removed) with factor loadings

| MAS no. | MAS items | **F1** | **F2** |
|---|---|---|---|
| mas25 | I listen to music so much that it has caused physical or health problems. | 0.758 | |
| mas13 | I listen to music so much that it negatively affects my daily obligations (e.g., school and work). | 0.754 | |
| mas14 | I give less priority to my daily obligations because of listening to music. | 0.751 | |

| | | | |
|---|---|---|---|
| mas19 | I have decided to spend less time listening to music but have not been able to do so. | 0.711 | |
| mas18 | I have been told by others to reduce the amount of time I spend listening to music but have not been able to take their advice. | 0.703 | |
| mas17 | I have tried to cut down the amount of time I spend listening to music. | 0.701 | |
| mas26 | I listen to music so much that it has impaired my well-being. | 0.580 | |
| mas20 | I have managed to limit the time I spend listening to music for periods and then experienced a relapse. | 0.577 | |
| mas28 | I have been bothered by a bad conscience because of listening to music. | 0.573 | |
| mas16 | I often end up in arguments with others because of music/listening to music. | 0.466 | |
| mas24 | If it has been a while since I last listened to music, I feel a strong urge to listen to music. | | 0.709 |
| mas23 | I feel bad if for some reason I am prevented from listening to music. | | 0.688 |
| mas05 | I listen to music to feel better (relieve stress). | | 0.631 |
| mas08 | I listen to music to reduce feelings of guilt, anxiety, helplessness, loneliness and/or depression. | | 0.619 |
| mas21 | I become stressed if I am prevented from listening to music. | | 0.596 |
| mas07 | I listen to music to forget my personal problems. | | 0.587 |
| mas09 | I feel an increasing inclination to spend time listening to music. | 0.314 | 0.581 |
| mas06 | I listen to music to feel good (gain pleasure). | | 0.575 |
| mas04 | Thoughts about music or listening to music keep popping into my mind. | | 0.521 |
| mas01 | Music or listening to music is the most important thing in my life. | | 0.516 |

### Correlations between MAS factors and other concepts

The results of the first correlation analysis (F1 and F2 generated by the second EFA, trimmed MAS addictive core, trimmed MAS engagement core, HUMS healthy, HUMS unhealthy, Gold-MSI AE, and Gold-MSI MT) appear in Table 6. The correlation between F1 and F2 was 0.06 ($p$=.377). The correlations between the two MAS core criteria and each F1 and F2 are F1-MAS addictive $r$=0.86 ($p$<.001), F1-MAS engagement $r$=0.27 ($p$<.001), F2-MAS addictive $r$=0.51($p$<.001), F2-MAS engagement $r$=0.88 ($p$<.001). The correlations between the two HUMS subscales (healthy and unhealthy) and each F1 and F2 are F1-HUMS healthy $r$=0.02 ($p$=.731), F1-HUMS unhealthy $r$=0.46 ($p$<.001), F2-HUMS healthy $r$=0.55 ($p$<.001), F2-HUMS unhealthy $r$=0.36 ($p$<.001). The addictive factor (F1) correlates moderately to HUMS unhealthy, and the engagement factor (F2) correlates moderately to HUMS healthy. The engagement factor correlates slightly to HUMS unhealthy, but the addictive factor correlates weakly to HUMS healthy. The Gold-MSI AE has a moderate correlation to the engagement factor and a weak correlation to the addictive factor. The Gold-MSI MT has weak correlations to both the addictive and engagement factors.

The second correlation analysis was conducted between the original 28-item MAS dimensions (salience, mood modification, tolerance, conflict, relapse, withdrawal, and problems) and the two core criteria. The results appear in Table 7. Six (salience, tolerance, conflict, relapse, withdrawal, and problems) out of seven dimensions correlate significantly to MAS addictive core criteria. Four (salience, mood modification, tolerance, and withdrawal) out of seven dimensions correlate significantly to MAS engagement core criteria. High cross-correlations (0.7<) were found between the two core criteria to each MAS dimension. Most of the removed cross-loadings generated by the first EFA were found to belong to the three cross-correlated MAS dimensions (salience, tolerance, and withdrawal). Based on the two results, F1 was defined as addictive and F2 was defined as engagement. The first result is the high correlation between the two MAS core criteria to each of F1 and F2, and the second result is that cross-loadings between F1 and F2 match the cross-correlating MAS dimensions.

Table 6. Correlation analysis and descriptive stats between F1 and F2 generated by the second EFA, trimmed MAS addictive core, trimmed MAS engagement core, HUMS healthy, HUMS unhealthy, Gold-MSI AE, and Gold-MSI MT.

| | MAS-F1 | MAS-F2 | trmd-MAS Addictive | trmd-MAS Engagement | HUMS Healthy | HUMS Unhealthy | MSI AE | MSI MT |
|---|---|---|---|---|---|---|---|---|
| MAS-F1 | | | | | | | | |
| MAS-F2 | 0.06 | | | | | | | |
| MAS Addictive | 0.86*** | 0.51*** | | | | | | |
| MAS Engagement | 0.27*** | 0.88*** | 0.58*** | | | | | |
| HUMS Healthy | 0.02 | 0.55*** | 0.27*** | 0.50*** | | | | |
| HUMS Unhealthy | 0.46*** | 0.36 | 0.56*** | 0.43*** | 0.19** | | | |
| MSI AE | 0.15* | 0.59*** | 0.40* | 0.55*** | 0.42*** | 0.26*** | | |
| MSI MT | 0.04 | 0.13* | 0.09 | 0.16 | 0.19 | 0.03 | 0.43*** | |
| Means | - | - | 2.57 | 4.21 | 4.02 | 2.01 | 4.7 | 3.25 |
| SD | - | - | 0.88 | 1.05 | 0.64 | 0.62 | 1.35 | 1.55 |
| Items | 1 | 1 | 13 | 7 | 5 | 8 | 9 | 7 |

* for $p<0.05$, ** for $p<0.01$, and *** for $p<0.001$.

Table 7. Correlation analysis and descriptive statistics between salience, mood modification, tolerance, conflict, relapse, withdrawal, and problems and the two core criteria.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1) MAS (Addictive core) | - | | | | | | | | |
| 2) MAS (Engagement core) | 0.74*** | - | | | | | | | |
| 3) MAS (Salience) | 0.70*** | 0.87*** | - | | | | | | |
| 4) MAS (Mood modification) | 0.44*** | 0.78*** | 0.50*** | - | | | | | |
| 5) MAS (Tolerance) | 0.74*** | 0.89*** | 0.71*** | 0.54*** | - | | | | |
| 6) MAS (Conflict) | 0.85*** | 0.56*** | 0.55*** | 0.28*** | 0.57*** | - | | | |
| 7) MAS (Relapse) | 0.83*** | 0.54*** | 0.52*** | 0.26*** | 0.56*** | 0.65*** | - | | |
| 8) MAS (Withdrawal) | 0.75*** | 0.77*** | 0.68*** | 0.58*** | 0.71*** | 0.49*** | 0.43*** | - | |
| 9) MAS (Problems) | 0.83*** | 0.51*** | 0.50*** | 0.26*** | 0.54*** | 0.69*** | 0.67*** | 0.43*** | - |
| Means | 2.57 | 3.88 | 3.36 | 4.78 | 3.48 | 2.11 | 2.40 | 3.57 | 2.22 |
| SD | 0.90 | 1.01 | 1.21 | 1.09 | 1.27 | 1.00 | 1.11 | 1.31 | 1.01 |
| Alpha | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 |

Table 7. Correlation analysis and descriptive statistics between salience, mood modification, tolerance, conflict, relapse, withdrawal, and problems and the two core criteria.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Items | 16 | 12 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

* for $p<0.05$, ** for $p<0.01$, and *** for $p<0.001$.

## DISCUSSION

A new measurement instrument called the Music Addiction Scale (MAS) was developed, and it was revised to differentiate effectively between addictive dependency on music and high engagement with music. By drawing the line between addiction and high engagement with music on whether the physical or mental consequences of general music behaviour are positive or negative, the newly developed MAS provides a comprehensive assessment for addictive dependency on music. Based on the results of the MAS, the suggested prevalence of addictive dependency on music among the sample was 3.61%, and the suggested prevalence of high engagement but not addictive among the sample was 21.69%. Nearly half of the participants of the study showed engagement with music (46.2%), which indicates that a large part of the general population can be affected by their musical activities. This increases the need and practicality of the MAS to explore a healthier use of music based on high engagement but addictive dependency on music.

According to the results of the one-way ANOVA analysis on HUMS scores and Gold-MSI scores between the three addictive level groups, the high addictive group has a higher risk of experiencing mental health issues defined by the Healthy-Unhealthy Music Scale (Saarikallio, Gold & McFerran, 2015). The medium addictive group, on the other hand, faces a lower risk of potential health issues caused by musical activities than the high addictive group. The low addictive group was shown to have the lowest risk for health issues caused by music compared to those who are more engaged in musical activities. This result was expected as minimum amount of engagement with musical activities is thought to be the initial condition to be influenced by musical activities in any ways. Based on the descriptive data of each subject groups, addicted, engaged, and ordinary group, although the high addictive group showed a significantly higher risk of experiencing health issues than other groups did, the high addictive group received no fewer beneficial effects from musical activities. The addictive dependency on musical activities does not necessarily lower the positive effects one could gain from music, but this addictive dependency on music does increase the risk of experiencing negative health issues compared to the engaged group. On the other hand, the engaged group scored the highest in the HUMS healthy subscale ($M=4.5$, $SD=0.46$). The comparison of the scores of the engaged group and the ordinary group shows that the engaged group scored slightly higher than the ordinary group in all aspects of musical activities studied. This suggests that the MAS has succeeded in filtering those who are highly engaged with music positively and healthily from within the population with ordinary engagement with music.

Both the addicted group and the engaged group scored high in the Gold-MSI AE facet, indicating a possible relationship between the background of active engagement in musical activities and current musical habits. Based on the result of the one-way ANOVA test, the Gold-MSI AE facet was scored significantly different between low addictive level group and the other two addictive level groups. However, no significant difference was found between medium addictive group and high addictive group. Therefore, a sophisticated background of

active engagement in musical activities may increase one's engagement with music in daily life, but it does not necessarily increase the risk of developing an addictive dependency on musical activities. Accordingly, it is important to know the proper way of using music to gain its positive effects at a higher level. Additionally, it was unexpected that instrumental lessons and training are neither necessarily helpful nor a hindrance to developing a healthier use of music. The results of both descriptive data and the one-way ANOVA test showed no significant difference in Gold-MSI MT scores between each of the subject groups and addictive level groups. Music training background does not directly increase or decrease the risk of developing an addictive dependency on musical activities. However, the results show a good strength of the correlation between the AE and MT facets. Thus, a background of MT may lead to having a stronger background of AE, and as a result, the background of AE increases the general engagement with music.

The two hypotheses concerned the effectiveness of the MAS and its two core criteria in targeting the right consequences as healthy and unhealthy use of music. The relationship between the two trimmed MAS core criteria and the two HUMS subscales were expected to be high positive correlations between MAS addictive core criteria, and HUMS unhealthy and weak or negative correlations with HUMS healthy were expected. Additionally, positive correlations between MAS engagement core criteria and both HUMS healthy and unhealthy were expected. The correlation score between MAS addictive core criteria and HUMS unhealthy was 0.56, which is a moderately high correlation. The correlation between MAS addictive core criteria and HUMS healthy was 0.27, which is a small correlation. The correlation scores between MAS engagement core criteria and both HUMS unhealthy (0.43) and the HUMS healthy (0.50) are moderately positive. In this case, a moderate correlation between variables is another supportive result for the development of the MAS. Although correlation scores between MAS core criteria and HUMS subscales are not significant between any variables, the MAS is not significantly duplicating the function of the HUMS. The uniqueness and the value as a measurement instrument would decrease if the MAS correlated to HUMS significantly between all the variables.

The factor analyses targeted the election of essential items for the measurement scale. The first EFA conducted on the original 28-item MAS detected eight cross-loadings between F1 and F2: mas02, mas03, mas10, mas11, mas12, mas15, mas22, and mas27 (see Table 5). Among these cross-loadings, mas02, mas03, mas10, mas11, mas12, and mas15 were the six items detected from the engagement core criteria. Similar to the results of the second correlation analysis, the engagement core criteria items cross-load more than items of the addictive core criteria do. This is a supportive result to the prior expectation of some overlapping items between the two core criteria. Additionally, the second EFA shows no change in the factors to which MAS items load. Therefore, the F1 was defined as the addictive factor and the F2 was defined as the engagement factor. Although F1 is loaded with only items from the addictive core criteria, F2 is loaded with most items from the engagement core criteria and three (mas21, mas23, and mas24) from the addictive core criteria. These

items belong to the conflict dimension of the MAS, which indicates that conflicts in musical activities would lead toward higher engagement but addictive dependency. The engagement factor (F2) is loaded significantly differently over different age groups, according to the result of the one-way ANOVA analysis. However, this result may be caused by the concentration of young participants within the study sample.

Multiple cross-correlated MAS dimensions between the two MAS core criteria of the original 28-item MAS were expected because engagement with music is essential for developing an addictive dependency (Charlton and Danforth, 2007). Therefore, in the case of music, some MAS items were expected to correlate to both addictive dependency and engagement. Based on the results (see Table 7), salience, tolerance, and withdrawal dimensions are involved in both addictive dependency and high engagement with music. Six out of eight of the removed cross-loadings that were generated by the first EFA were found to belong to these three cross-correlated MAS dimensions. This means that six out of 12 items that make up the engagement core criteria relate to addictive core criteria, which is a large part of these criteria. On the other hand, mood modification, conflicts, relapse, and problems are involved more in either addictive dependency or high engagement and less in the others. Conflicts, relapses, and problems are involved more in addictive dependency on music than in high engagement. Mood modification is involved more in high engagement with music than in addictive dependency on music.

Characteristic comparisons of addictive dependency on musical activities and other addictive behaviours were based on the findings of the present study. First, addictive dependency on music (3.61%) is less likely to be developed compared to some other addictive behaviours such as gaming addiction (4.2%), reported by Brunborg et al. (2013), and workaholics (7.4%), reported by Andreassen et al. (2012). In addition, among aspects of the addictive dependency on musical activities, the categorization of each dimension into the two core criteria may vary depending on different behaviours. The categorization of the MAS dimensions into the engagement core criteria and the addictive core criteria followed the procedure reported by Charlton and Danforth in an investigation of online gaming addiction (2007). Although the dimension of the conflict was originally one of the addictive core criteria in the study by Charlton and Danforth, in the present study, the aspect of the conflict of musical activities was found to be loaded more with the engagement factor than the addictive factor. Overall comparisons between the addictive dependency on musical activities and other reported addictive behaviours show that the chance of developing an addictive dependency on musical activities is relatively small, and the lesser aspects of behavioural addiction are involved in the addictive dependency on musical activities.

### How to Engage with Music without Addictive Dependency

Based on the results and interpretations made in the present study, a potentially healthier way of enjoying music in everyday life is suggested. First, people should be aware of the purpose and motivation for their musical activities. A study by Garrido and Schubert

(2013), reported that music listeners with high scores in ruminating did not necessarily like the provided sad music, but their overall listening habits showed attraction to the sad music. The study also indicates that these listeners may believe they are benefiting from the purging to their negative emotions through music, while it appears that such behaviours only perpetuate feelings of dysphoria. Therefore, it is important for one to know in what purpose music will be used and what possible effects the music may deliver to correctly benefit from musical activities. The present study indicates that mood modification is an effective way of using music for increasing engagement with music more than increasing the risk of developing an addictive dependency. On the other hand, the chance of developing an addictive dependency on music is higher when relapse and problems are involved in musical activities. For instance, people should re-consider their habits of music consumption if their daily obligations are being negatively affected by the musical activities or they feel unable to control how much time they spend on musical activities before developing health problems such as sleep issues and auditory issues. According to the result of the second EFA, conflict items are found to load to the engagement factor more than to the addictive factor. Therefore, one does not have to worry about feeling more urge to listen to music after not listening to mussic for a while or to feel bad about being preventing from musical activities. Lastly, since sophistication background was found to be beneficial for increasing engagement in musical activities in daily life, musical education from a young age is encouraged.

Although the present study found no direct relationships between musical training background and the development of higher engagement, MT can be supportive of AE in musical activities. Therefore, musical education and activities from a young age can be helpful for the youngsters to develop higher engagement with music later, but the music education and activities should involve more dimensions (salience, tolerance, mood modification) from the MAS engagement core criteria than the MAS addictive core criteria. This allows a more significant gain of the positive effects of music, such as improved mood and physical performances, in daily life.

## LIMITATIONS and FUTURE RESEARCH

To use MAS for further research in the field of music and science, the newly developed MAS must be further evaluated in future studies. First, the newly revised trimmed 20-item MAS will need to be tested to validate its functionality and accuracy for assessing addictive dependency in engagement with musical activities. Another limitation that should be acknowledged is the small size of the sample. Although the broad range of cultural and nationality backgrounds of the studied sample is one of the present study's key strengths, detailed groupings between different countries and cultural backgrounds were not done in the presented study. The total size of the sample is rather small considering the number of items included in the online survey. In addition, the overall age distribution of the sample was concentrated between 20 and 30 years old. More data from other age groups would be required in the future to conduct reliable analysis of the cultural and national background of

the sample. To do this, the MAS needs to be tested within a larger sample, and the captured factor structure and loaded items should be confirmed through confirmatory factor analysis (CFA). An additional benefit of a larger sample with similarly broad cultural and nationality backgrounds would provide future research with more reliable data within different cultural groups, nations, ages, and other groups with different categorizations.

Although another round of tests in a larger sample is needed for the validation of the MAS, the present study suggests that music addiction can be captured with a survey instrument as other addictions. One difficulty of studying addictiveness in musical activities is finding clinical examples of music addiction, which is a common yet severe difficulty in researching addictive behaviours. A clear definition of music addiction is required before looking for clinical examples. Defining music addiction requires a much larger database for the MAS to capture how addictiveness is formed through musical activities. Therefore, the validation and confirmation of the MAS will be the task for both defining the music addiction and finding clinical examples of music addiction.

For future research in potentially addictive musical activities, the MAS can be used as a generic measurement instrument because the MAS is capable of a comprehensive assessment of addictive behaviours from musical habits. It is comprehensive because the MAS is designed to assess not only one specific pattern of musical behaviour but various situations and contexts that may form a wrong way of enjoying music. Specifically, the MAS can be used for assessing addictive-like musical behaviours that have already been reported in studies, such as excessive music practice (Ahrends, 2017) and self-exposure to loud music (Schmuziger et al. 2012). By re-assessing these potentially addictive musical behaviours with the MAS, a more detailed investigation of the cause of the addictive dependency on the studied musical behaviour can be performed. Another strength of the present study is the use of a strictly statistical approach for the development of the MAS and its analysis. This enables the MAS to be used in both in-person interviews and online survey interviews, although online surveys can sometimes fail to observe what in-person interviews would see, such as participants' live reactions and voice tones. A measurement instrument based on a strict statistical procedure would collect the same data with the same sample no matter if the data were collected through in-person interviews or online survey interviews. Although the present study did not collect clinical background information from the participants, future research in the field of music therapy and clinics should be encouraged to use the MAS to assess potential treatments for well-being issues caused by musical activities.

## CONCLUSION

The present study reported the process of the development of the MAS and demonstrated that the revised MAS is ready to be studied further for validation and confirmation. The MAS has a good psychometric structure, generic measuring ability, and an interpretable dimensional structure. The removal of high cross-loadings of the EFA from the MAS has turned the MAS into a better and more robust measurement instrument for assessing

addictive dependency on music from positive engagement with music. The validation of the revised MAS will make it the first measurement instrument for a comprehensive investigation of addictiveness in music. Such an instrument can be useful for future investigation of maladaptive use of music by assessing one's holistic musical activity, which enables various groupings depending on the researcher's needs. The present study explored the mechanism of addictive dependency on music by investigating the relationship between MAS dimensions and the addictive factor and the engagement factor. Based on the results, the present study has suggested tips for higher engagement with music while avoiding the negative use of music. It has investigated the characteristic difference between the addictive dependencies on musical activities and other addictive behaviours. Although the MAS still needs to be validated through further studies and analysis, its development has shown it to be promising in exploring the relationship between music and mental or physical well-being.

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Appendix 1. First EFA on the original 28-item MAS with factor loadings

| Items | F1 | F2 |
|---|---|---|
| mas23 | 0.71 | 0.24 |
| mas24 | 0.70 | 0.13 |
| mas05 | 0.63 | -0.09 |
| mas21 | 0.62 | 0.27 |
| mas11 | 0.62 | 0.35 |
| mas09 | 0.61 | 0.30 |
| mas08 | 0.60 | 0.07 |
| mas07 | 0.57 | 0.23 |
| mas12 | 0.56 | 0.32 |
| mas06 | 0.55 | -0.17 |
| mas03 | 0.55 | 0.34 |
| mas02 | 0.55 | 0.43 |
| mas22 | 0.54 | 0.31 |
| mas01 | 0.53 | 0.28 |
| mas04 | 0.53 | 0.26 |
| mas10 | 0.46 | 0.46 |
| mas14 | 0.12 | 0.75 |
| mas25 | 0.02 | 0.74 |
| mas13 | 0.12 | 0.73 |
| mas19 | 0.31 | 0.70 |
| mas17 | 0.06 | 0.69 |
| mas18 | 0.20 | 0.68 |
| mas28 | 0.19 | 0.58 |

Appendix 1. First EFA on the original 28-item MAS with factor loadings

| | | |
|---|---|---|
| mas26 | 0.13 | 0.57 |
| mas20 | 0.28 | 0.57 |
| mas15 | 0.43 | 0.51 |
| mas27 | 0.37 | 0.48 |
| mas16 | 0.26 | 0.46 |

Appendix 2. HUMS items (matched order in the survey)

| | Items |
|---|---|
| HUMS1 | When I listen to music I get stuck in bad memories. |
| HUMS2 | I like to listen to songs over and over even though it makes me feel worse. |
| HUMS3 | It can be hard to stop listening to music that connects me to bad memories. |
| HUMS4 | I hide in my music because nobody understands me, and it blocks people out. |
| HUMS5 | When I try to use music to feel better I end up feeling worse. |
| HUMS6 | Music gives me an excuse not to face up to the real world. |
| HUMS7 | Music makes me feel bad about who I am. |
| HUMS8 | Music leads me to do things I should not do. |
| **HUMS9** | **I feel happier after playing or listening to music.** |
| **HUMS10** | **Music gives me the energy to get going.** |
| **HUMS11** | **When I'm feeling tense or tired in my body music helps me to relax.** |
| **HUMS12** | **Music helps me to relax.** |
| **HUMS13** | **Music helps me to connect with other people who are like me.** |

*Items in bold scale are HUMS healthy subscale and others are HUMS unhealthy subscale.

Appendix 3. Gold-MSI items (AE and MT)

| MID | Item |
|---|---|
| AE_01 | I spend a lot of my free time doing music-related activities. |
| AE_02 | I enjoy writing about music, for example on blogs and forums. |
| AE_03 | I'm intrigued by musical styles I'm not familiar with and want to find out more. |
| AE_04 | I have attended _ live music events as an audience member in the past 12 months. |
| AE_05 | I often read or search the internet for things related to music. |
| AE_06 | I don't spend much of my disposable income on music. |
| AE_07 | Music is kind of an addiction for me - I couldn't live without it. |
| AE_08 | I listen attentively to music for _ per day. |
| AE_09 | I keep track of new music that I come across (e.g. new artists or recordings). |
| MT_01 | I engaged in regular, daily practice of a musical instrument (including voice) for_ years. |
| MT_02 | At the peak of my interest, I practiced my primary instrument for _ hours per day. |
| MT_03 | I have never been complimented for my talents as a musical performer. |
| MT_04 | I have had formal training in music theory for _ years. |
| MT_05 | I have had _ years of formal training on a musical instrument (including voice) during my lifetime. |
| MT_06 | I can play _ musical instruments. |
| MT_07 | I would not consider myself a musician. |