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Self-determined motivation for practice in university music students

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Abstract

This study adopted self-determination theory as means to understanding the motivation of university music students. The self-determination theory framework contends that three psychological needs of competence, relatedness, and autonomy must be fulfilled in order to maintain psychological wellbeing. In turn, needs fulfilment results in autonomous motivation, in which activities are perceived to be aligned with the self and are consequently experienced as personally important, interesting, and enjoyable. We surveyed students (N = 392) from schools of music in nine universities in Australia and New Zealand to examine whether needs fulfilment and autonomous motivation within the university music learning context would explain context-specific affect and behaviour. Hypothesised relationships were tested using structural equation modelling. Psychological needs fulfilment and autonomous motivation explained more frequent practice, more frequent quality practice, and a higher preference for challenging tasks. This study is among the first self-determination theory studies in the domain of music learning at the university level, and thus the results are described in terms of the potential of this theory to more fully explain interesting and under-researched aspects of this environment, including student wellbeing, anxiety, preparations for a long-term career in music, and pedagogical implications.

Keywords

autonomy, conservatoire, motivation, music education, practice, psychological needs, self-determination theory

Learning instrumental music performance at the university level can be difficult. Students face considerable challenges, including developing a relationship with a studio teacher, learning to cope with competitive social environments, and planning for an uncertain and testing career (Bennett & Stanberg, 2008; Gaunt, 2011).

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Among these difficulties is sustaining the many hours of practice required to develop performance ability. Practice is a skill that students must hone without much substantial guidance, because in studio lessons, technique and repertoire tend to be prioritised, and little instructional time is devoted to the structure and strategy of practice (Jørgensen, 2009). For the most dedicated music students, this means that a large proportion of their waking hours is spent on an activity that is relatively unguided and ill-defined (Barry & Hallam, 2002; Jørgensen, 2000; Renwick & McPherson, 2002).

As with any other setting, motivation and engagement in learning music at university depends on the learning environment. Learning is challenging for university music students if their environment is not conducive to effective motivation and engagement. In music at university level, particularly in conservatories and classical performance-based degree programs, research suggests that the studio music environment is often not optimal for student motivation. Studio teaching often adopts a demanding, directive, and controlling style (Creech & Gaunt, 2013; Gaunt, 2011). Even though they may not intend to, teachers can easily dominate lessons by talking and issuing technical demands, with little input from the student (Bonneville-Roussy, Vallerand, & Bouffard, 2013; Burwell, 2015; Young, Burwell, & Pickup, 2003). This style of teaching can probably be attributed to the master–apprentice relationship that has long been a tradition (Jørgensen, 2000), with its roots possibly in the boom of the industrial revolution, where printed method books proliferated, instrument ownership became commonplace, and the music studio teaching industry flourished (Gellrich & Parncutt, 1998).

Evidence suggests that this authoritarian approach to teaching may be problematic for students' motivation to practice. In school settings, a controlling teaching style – one that is directive, where the teacher talks and the student listens, and in which students do not feel any autonomy – results in less student engagement, less deep learning, and less creativity (Niemiec & Ryan, 2009; Reeve, 2009; Su & Reeve, 2010). This finding is consistent in other domains such as parent–child relationships (Grolnick, 2003, 2009), health care (Ng et al., 2012), and work relationships (Gagné & Deci, 2005). Learning more about whether this finding applies to the music learning context is therefore important (Evans, 2015).

Our aim with the present study was to better understand this issue by studying how university music students are motivated, and how motivation affects three aspects of their practice: (1) how often they practice (practice frequency); (2) how often they practice in a way that they perceive to be highly productive or rewarding (quality practice frequency), and (3) their preference for choosing challenging tasks above tasks that are easy and within their ability (preference for challenge). Self-determination theory (SDT) formed the theoretical approach to our understanding of students' motivation. SDT's central claims are that people's behaviour, engagement, and wellbeing are products of the quality of their interactions with the social environment (Ryan & Deci, 2000). This study instantiates a broader endeavour to understand the conditions in the social environment that are needed for students to experience wellbeing, aspire to learn, and fulfil their potential for performance excellence.

Practice

Practice is one of the crucial learning activities for university music students. Music students are often required to do large amounts of practice in order to attain technical and musical expertise, become proficient on their instrument, and reach a standard that allows them to pursue a career in music performance. The most successful musicians know that *deliberate* practice – effortful, strategic, conscious practice – is necessary to produce reliable and consistent improvements in performance (Barry & Hallam, 2002). Yet sustaining large amounts of

deliberate practice is inherently difficult, and the motivation required for it is complex (Evans, 2015). Much like in other domains, deliberate practice in music is not usually inherently enjoyable in and of itself (Ericsson, Krampe, & Tesch-Römer, 1993). It occurs mostly in social isolation, is cognitively demanding, and requires consistent attention and focus.

The deliberate practice framework of Ericsson et al. (1993) has been accepted as the primary explanation for expert performance for the last two decades. It is based on the finding of substantially higher accumulations of deliberate practice among expert performers compared with non-experts – a finding initially made with university music students. Some debate has arisen in recent years with the suggestion that deliberate practice may not account for as much variance as the deliberate practice approach claims. For example, recent re-analyses of data from a number of studies found that deliberate practice accounted for only around 30% of the variance in performance ability, leaving 70% of the variance explainable by other factors (Hambrick, Altmann, Oswald, Meinz, & Gobet, 2014). Another study found an average correlation between deliberate practice and performance of only around .35 (Macnamara, Hambrick, & Oswald, 2014). Bonneville-Roussy and Bouffard (2015) also found that formal practice explained only 18% of the musical achievement of college music students. Ericsson defended these challenges (Ericsson, 2014a, 2014b) stating that the deliberate practice framework is relevant only to expertise, not other types of performance, and that the criteria for including studies in the Macnamara et al. meta-analysis were too broad.

The debate highlights the need to understand more fully the nature of practice and its relationship with performance ability. Nevertheless, there can be no doubt that deliberate practice accounts for a substantial proportion of variance in expert performance and in performance more generally. Furthermore, there appears to be little doubt that deliberate practice is an absolutely necessary activity for developing expertise in the training of musicians at the university level. In addition, the debate may be further clarified by examining not only the amount of practice undertaken (frequency of practice), but also the degree to which practice is in fact deliberate (quality practice). One of the ways that the deliberate practice framework explains these factors is through a number of constraints initially identified by Ericsson et al. (1993), including the motivational constraint.

Motivation to practice

When Ericsson et al. (1993) outlined their deliberate practice framework, they explained that not all people can easily accumulate the many hours of practice that appear necessary to attain expertise. They identified three 'constraints' on the attainment of such a large number of hours of practice. The *effort* constraint restricts the ability of a person to maintain full attention for sustained amounts of time; the *resources* constraint limits access to equipment, access to specialist teachers, transportation to lessons, and training facilities; and the *motivational* constraint is based on the assumption that 'deliberate practice is not inherently enjoyable, and that individuals are motivated to engage in it by its instrumental value in improving performance' (Ericsson et al., 1993, p. 371). The motivation construct is the focus of the present research. Understanding the circumstances under which practice may be experienced as enjoyable or not, and the extent to which people understand the instrumental value of practice in improving performance, would help universities, teachers, and students to create optimal practice environments (Evans, 2015).

Motivation is therefore important to study because it constrains the amount of practice people are able to undertake. But it is also important to study because it influences behaviours other than practice. People's motivational beliefs – including beliefs about abilities, beliefs about

whether certain activities are useful in attaining goals, and beliefs about why people do what they do – play a substantial role in guiding their behaviours. Motivation also accounts for affective states, psychological wellbeing, the development of personal identity and sense of self, and the resilience and determination to confront and overcome challenges, all of which are important to musicians. One of the most prominent theories in motivation in recent years – self-determination theory – broadly addresses these facets of human life and has been applied to domains such as education, work, sports, personal relationships, and physical and psychological health (Ryan & Deci, 2000). It is a useful framework for understanding motivation for learning music and its relationships with practice and wellbeing (Evans, 2015).

Self-determination theory

Self-determination theory (SDT) is an approach to human motivation that describes the social circumstances under which people experience wellbeing and vitality. Research in SDT began with research on one of the most consistent distinctions in the study of motivation: the concepts of intrinsic and extrinsic motivation (Deci, 1971). These constructs are relatively agreed upon across the motivation literature: intrinsic motivation is doing an activity for its own sake and because it is enjoyable or interesting, such as playing one's favourite, learned piece of music for pleasure; while extrinsic motivation is doing an activity for any reason other than the activity itself, for example, to get a good grade, to avoid some kind of punishment, or because it is important in attaining some other goal. Within SDT, extrinsic motivation is further elaborated, with four different regulatory types, from relatively external to the self to relatively internal and aligned with the self (Ryan & Deci, 2000). For example, relatively external regulations (viz., extrinsic and introjected regulation) could be a teacher or parent telling you what to do, the possibility of a good grade, the avoidance of feeling guilty. Relatively internal regulations (viz., identified and integrated regulation) could be the understanding of how important a task is, realising that a task is instrumental to achieving other personally important goals, or seeing that the task is an important part of who you are. While these more internalised regulations are considered extrinsic motivation, they are aligned with one's interests and goals, so their behaviours are considered by SDT as being relatively self-determined. The more important distinction in SDT, therefore, is the alignment of activities with one's sense of self, rather than whether the activity is intrinsically or extrinsically motivated. In SDT, relatively internal regulations are considered to be more autonomous forms of motivation than relatively external regulations (for a more thorough review, see Evans, 2015).

Autonomous motivation is fuelled by the fulfilment of basic psychological needs. According to SDT, there are three basic psychological needs which, when fulfilled, provide nutriments for growth, vitality, and wellbeing (Deci & Ryan, 2000). The needs comprise the need to feel effective and able in one's efforts and in interacting with the social environment (competence), the need to feel accepted and connected by others in social networks (relatedness), and the need to feel as though one's actions are aligned with one's sense of self (autonomy). When people's psychological needs are fulfilled within a domain, they experience the domain as more enjoyable, they engage in activities with meaning and purpose, and they experience wellbeing in domain-related contexts.

In domains related to music learning, the SDT framework is supported by a wealth of evidence. In education, for example, studies have found that when teachers are autonomy supportive and provide structure, their students are more engaged (Jang, Reeve, & Deci, 2010), and when they are more controlling, their students suffer (Soenens, Sierens, Vansteenkiste, Dochy, & Goossens, 2012). Another consistent finding is that intrinsic motivation is associated with

academic achievement (for a recent review and meta-analysis, see Taylor et al., 2014). In countless applied domains, SDT research shows that psychological needs fulfilment and internalised forms of motivation explain more autonomous, healthy forms of functioning and account for substantial variance in outcomes such as creativity, deep learning, wellbeing, passion, and growth.

Researchers have begun to explore SDT's applications in music education. In one study, psychological needs in children and adolescents were more fulfilled when they were highly engaged in their music learning than at the time they ceased music learning activities (Evans, McPherson, & Davidson, 2012). One of these children was observed in a qualitative study to use more sophisticated practice strategies in her practice when she had autonomously self-selected her repertoire (Renwick & McPherson, 2002). In another study, different types of motivation regulation in children were associated with practice behaviours – effort management, monitoring, and strategy use – and motivated students to prepare for performance examinations in different ways (Renwick & Reeve, 2012). In university students, Bonneville-Roussy et al. (2013) showed that autonomy support from music teachers led to more harmonious passion and ultimately to greater persistence in music education whereas controlling behaviours from teachers were not linked to persistence. (For a conceptual overview of SDT in music education, see Evans, 2015.) No study, to our knowledge, has yet examined university students' practice quantity or practice quality using self-determination theory.

The present study

The aim of the present study was to test, within a SDT theoretical framework, how the perception of needs satisfaction from the music learning environment can shape university music students' motivation towards music, and, in turn, the frequency and quality of their practice. Past research has shown that satisfaction of the needs for autonomy, competence, and relatedness promotes more self-determined forms of motivation (Deci & Ryan, 2000; Hagger, Chatzisarantis, & Harris, 2006). Therefore, we hypothesized that music students who perceived that their psychological needs were satisfied by their musical environment would have more autonomous motivation towards music.

In addition, past research in other educational areas has found that autonomous motivation is linked to better engagement, persistence, and overall academic success (Deci, Vallerand, Pelletier, & Ryan, 1991; Niemiec & Ryan, 2009). In the present study, three aspects of practice behaviour were examined: practice frequency (how often the students practised), quality practice frequency (i.e. how often practice was productive or rewarding), and preference for challenge (the degree to which students preferred to set themselves challenges that exceeded their ability but were within reach, as compared with choosing tasks that were comfortable and well within their ability). In line with past research, we hypothesized that more autonomous motivation would lead to higher practice frequency, higher quality practice frequency, and higher preference for challenge. We tested these hypotheses using structural equation modelling.

Method

Participants

Participants were 410 university music students from nine schools of music at universities in Australia and New Zealand. Students were enrolled in undergraduate music degree programs

in which music performance is a core requirement, and in which students receive regular studio tuition. There were 146 (36%) males, 256 (63%) females, and 3 selected 'other' or chose not to respond. The mean age was 21.61 years (SD = 5.49). The participants completed the consent process and the survey online. Administrators in each of the nine universities were asked to forward a link to the online survey to all students in undergraduate music programs that had performance as a substantial component. Ethics approval was obtained for the study from the UNSW Human Research Ethics Advisory Panel.

Measures

Psychological needs satisfaction. Competence, relatedness, and autonomy were measured based on the Balanced Measure of Psychological Needs (BMPN; Sheldon & Hilpert, 2012). In this scale, the needs are measured using three positively-worded and three negatively-worded items each, resulting in 18 items (only the positively-worded items were used in the present study to examine psychological needs satisfaction). Participants responded to each item on a 7-point scale from 'not at all true' to 'very true'. To measure the needs in the intended context, the stem 'In my music learning and playing, …' was stated before the set of 18 items. The BMPN is a domain-general measure of psychological needs, so minor changes to some item wordings were made so that the items were appropriate to the context (e.g. 'I successfully learn difficult things' was adapted to 'I successfully learn difficult music'). We refer to this adapted instrument as BMPN–Music throughout this paper.

Autonomous motivation. Measures were adapted from Ryan and Connell's (1989) widely-used measures of these types of motivation in academic settings, the self-regulation questionnaire (SRQ); we refer to our minor adaptation as SRQ–Music throughout this paper. Two blocks of items were presented, with the stems 'Why do you play and learn music?' and 'Why do you have music lessons?', respectively. In each block, four types of motivation regulation were measured, ranging from relatively external to relatively internal regulation, by two items each: extrinsic regulation (e.g. 'because I am supposed to'), introjected regulation (e.g. 'so I can show off my abilities'), identified regulation (e.g. 'because I wanted to be a good musician'), and intrinsic motivation (e.g. 'because I love playing my instrument'). These items were parcelled and used as indicators of a single latent variable named 'autonomous motivation' (see Results section).

Practice frequency. Participants were asked 'How many times have you practised on your instrument in the last 7 days (do not include lessons)?' to measure the frequency of their practice.

Quality practice frequency. We assessed practice quality using a single item, "How many of your practice sessions in the last 7 days were really productive or rewarding?"

Preference for challenge. We asked participants to respond to the item, 'Next time I select a new piece of music to play, it will be …' on a 7-point scale from 'well within my ability' to 'challenging and above my ability'.

Affect. We asked participants how much they felt affective states in their music learning and playing – happy, relaxed, excited, proud, unhappy, nervous, guilty, and angry – in response to the question, 'In my music learning and playing, I feel …'.

Results

Analytical approach

We addressed the aims of this project within the analytical framework of structural equation modelling (SEM). SEM is a statistical method that aims at measuring the relationship between a set of variables and assessing causal relationships between constructs. It uses model fit indices to evaluate whether the modelled relationships between variables are a meaningful representation of the data. Confirmatory factor analysis (CFA) in the SEM framework has several advantages compared with traditional exploratory factor analysis (Brown, 2006; Muthén & Muthén, 2010). First, model fit indices allow researchers to assess whether the number of factors retained in a given analysis provides appropriate fit to the data. Second, it provides a standard error of means for the observed variables. This allows researchers to test the significance of an observed variable on a latent construct. Measurement models in SEM also provide error variances of observed variables that indicate the amount of unexplained variance. Finally, CFA tests for more stringent, theory-driven measurement models, as the observed variables are hypothesized to be represented by only one factor.

In our analyses, model goodness-of-fit was evaluated according to the recommendations of Marsh et al. (2009). That is, a model was deemed to have acceptable fit with a comparative fit index (CFI) equal to or higher than .90 (and an excellent fit equal to or greater than .95) and a root mean square error of approximation (RMSEA) and standardized root mean square residuals (SRMR) equal to or less than .08 (or less than .05 for an excellent fit). The issue of chi-square has been debated. Traditionally, it has been argued that non-significance of chi-square should be met; however, as chi-square indices are inflated by sample sizes and model complexity (number of degrees of freedom), they are more likely to be significant when larger sample sizes are used and when the model has a high degree of complexity (Brown, 2006; Kline, 2010). Therefore, in this work, chi-square statistics are interpreted with caution.

In the approach to the present study, we took advantage of SEM in several ways. First, we performed two CFAs to confirm the validity of our psychological needs satisfaction and autonomous motivation scales. Based on the results of these CFAs, we then computed variables for needs satisfaction and relative autonomy index (RAI) parcels for use in subsequent analyses. We used a full structural equation model to address our main research objectives. Finally, we present computed factor scores and their correlations with affect variables to more fully understand the relationships between motivation, practice, and affect. All of the analyses were performed using Mplus version 7.3 (Muthén & Muthén, 2014).

Psychological needs satisfaction scale (BMPN–Music)

We used a CFA to examine the validity of the three needs satisfaction dimensions (autonomy, competence, and relatedness). Since the BMPN–Music measures the three psychological needs using positively and negatively worded items, we conducted a second-order CFA to assess, first, the validity of the positive and negative valence of each sub-scale (e.g. autonomy positively worded and autonomy negatively worded, for a total of six subscales). Then we assessed whether these positive and negative subscales (e.g. autonomy satisfaction, autonomy thwarting) formed single latent constructs (e.g. autonomy) in a second higher-order factor analysis. Results confirmed that the second-order factor analysis fit the data well, $\chi^2_{125} = 233.42$, $p < .001$, CFI = .96, TLI = .95, RMSEA = .05 (95% CI = .04–.06), SRMR = .06. Standardised loadings on the factors ranged from .51 to .83 for the lower-order subscales and varied from -.46 (negative subscale) to

1.00 (positive subscale) for the higher-order dimensions, with all loadings significant at $p < .001$ (specific loading values are available from the corresponding author). These results confirm the validity of the BMPN–Music scale.

Given our sample size limitations, and the requirement for model parsimony, we created item parcels for the psychological needs by summing the individual positively-worded items within each need. The higher-order CFA above justified this approach of using composite scores for competence, relatedness, and autonomy.

Autonomous motivation scale (SRQ–Music)

To examine the factor structure of the autonomous motivation scale, we performed a CFA with the 16 SRQ–Music observed variables. These variables have been shown in past research to represent four types of motivation regulation, with four items representing each form of regulation, from relatively internal to relatively external: intrinsic, identified, introjected, and external (Ryan & Connell, 1989). Results of the CFA confirmed the four-factor structure of the scale, $\chi^2_{94} = 226.91$, $p < .001$, CFI = .94, TLI = .93, RMSEA = .06 (95% CI = .05–.07), SRMR = .06. Standardized loadings on the factors ranged from .39 to .88 and all were significant at $p < .001$ (specific loadings are available from the corresponding author). These results show that the four types of motivation are well represented by their corresponding items.

In the subsequent structural model, we required a single measure of autonomous motivation to maximise statistical power and to best take advantage of the sample size. To use the SRQ–M items as a single measure of motivation internalisation, we adopted the approach used in previous research (e.g. Niemiec et al., 2006; Ryan & Connell, 1989) of creating a relative autonomy index (RAI). In the RAI, more weight is put on intrinsic and extrinsic forms of regulation. A higher positive score indicates a more autonomous motivation. Ryan and Connell (1989) first developed the RAI by using weighted measures of each type of regulation, such that:

$$\text{RAI} = 2\times\text{Intrinsic} + \text{Identified} - \text{Introjected} - 2\times\text{Extrinsic}$$

We employed this procedure to create item parcels: four parcelled RAI indicator variables were computed based on the equation above, selecting one item randomly from each of the four types of extrinsic motivation in the SRQ–Music. In the subsequent structural model, the item parcels were used as indicators of a latent variable, which we named autonomous motivation.

Descriptive statistics

To detect and remove multivariate outliers, we computed the Mahalanobis distance using all variables in the path analysis model below. Mahalanobis distances were standardised, and a total of 8 cases with scores greater than 3 standard deviations from the mean were removed.

Descriptive statistics and correlations for all observed variables are presented in Table 1. Small to moderate correlations were observed, as expected, between practice variables and almost all of the motivation variables used in the following models.

Full SEM of needs satisfaction, autonomous motivation, and musical practice

Table 2 presents the descriptive statistics and correlation coefficients of the variables included in our main hypothesized model. Because our three measures of practice were skewed, we used

Table 1. Descriptive statistics and correlation coefficients of the observed and parcelled variables included in this study.

Variables	*Mean*	*SD*	1	2	3	4	5	6	7	8	9
1. Practice frequency	5.64	2.38	–								
2. Quality practice frequency	3.86	1.97	.82*	–							
3. Preference for challenge	5.08	2.25	.23*	.31*	–						
4. Competence	14.88	3.86	.12*	.19*	.39*	–					
5. Relatedness	14.47	3.80	.04	.09	.17*	.26*	–				
6. Autonomy	16.32	4.04	.07	.15*	.22*	.39*	.42*	–			
7. RAI1	11.53	3.40	.15*	.22*	.20*	.19*	.18*	.33*	–		
8. RAI2	10.49	3.24	.10	.18*	.15*	.20*	.15*	.26*	.62*	–	
9. RAI3	9.28	3.05	.16*	.19*	.18*	.19*	.10	.26*	.50*	.48*	–
10. RAI4	9.30	3.05	.21*	.25*	.09	.17*	.14*	.32*	.42*	.47*	.49*

Note: $N = 392$; RAI = Relative Autonomy Index.
*$p < .01$.

Table 2. Descriptive statistics and correlation coefficients of the variables of the structural model of self-determined motivation.

	M	*SD*	Skewness	Kurtosis	1	2	3	4
Psychological needs	0	1.64	−0.45	−0.03	–			
Autonomous motivation	0	3.14	−0.09	−0.40	.53*	–		
Practice frequency	5.69	3.91	1.88	4.86	.11	.20*	–	
Quality practice frequency	3.92	2.71	1.63	3.40	.16*	.30*	.82*	–
Preference for challenge	5.08	1.32	−0.78	0.90	.14*	.27*	.06	.08

Note: $N = 392$.
*$p < .01$.

the maximum likelihood with robustness to non-normality (MLR) estimator, which computes means and standard errors that are robust to non-normality of the data. The MLR scaling for correction was 1.08, meaning that only a minor correction was required for this model. Psychological needs satisfaction was modelled as a latent variable indicated by autonomy, competence, and relatedness satisfaction items. Autonomous motivation was modelled as a latent variable indicated by four RAI item parcels.

A first analysis was conducted with psychological needs satisfaction being explained by the autonomy, competence, and relatedness needs dimensions. Psychological needs satisfaction predicted autonomous motivation. Finally, autonomous motivation predicted our three practice variables: practice frequency, quality practice frequency, and preference for challenge. The fit indices of this initial model did not meet the threshold of adequacy, $\chi^2_{33} = 106.28$, $p < .001$; RMSEA = .08 (.06–.09); CFI = .92; TLI = .89; SRMR = .07. The examination of modification indices revealed that two of the RAI item parcels were significantly related ($\beta = .31$, $p < .001$), and allowing them to co-vary would significantly increase the fit of our model. This model with an added relationship between two residuals is presented next.

The overall fit information of the final model was adequate, indicating that our data fit the hypothesized links well, $\chi^2_{32} = 94.08$, $p < .001$; RMSEA = .07 (.05–.09); CFI = .93; TLI = .90;

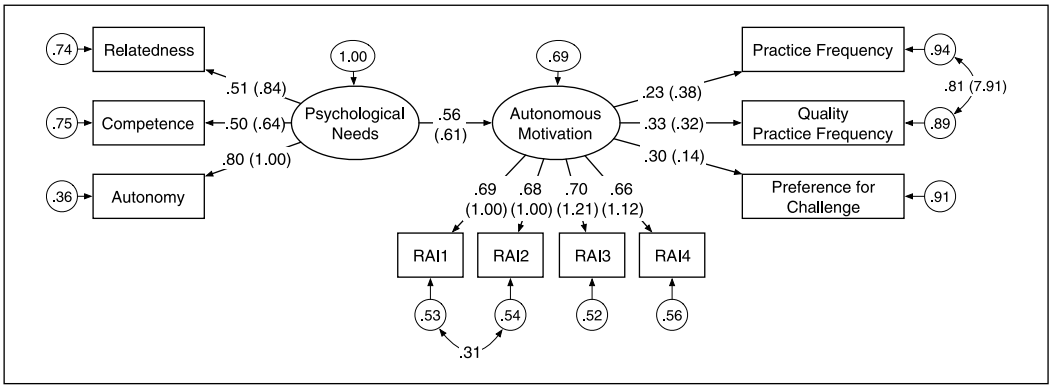

Figure 1. Structural equation model of psychological needs satisfaction and autonomous motivation predicting practice. *N* = 392. Unstandardized coefficients are in parentheses. All factor loadings and paths are significant at $p < .001$. RAI = Relative Autonomy Index.

SRMR = .06. This final model is presented in Figure 1. In summary, psychological needs satisfaction was successfully explained by the satisfaction of the needs for autonomy, competence, and relatedness. In addition, autonomous motivation was adequately explained by the four RAI parcelled measures. Autonomous motivation was predicted by psychological needs satisfaction. In turn, autonomous motivation was significantly related to practice frequency, quality practice frequency, and preference for challenge, our three measures of practice behaviour. This model explained 6% of the variance in practice frequency, 11% of the variance in the frequency of quality practice, and 9% of the variance in preference for challenge.

We also found indirect effects. The links between needs satisfaction and practice time was significantly mediated by autonomous motivation ($\beta = .13$, $p < .001$). Autonomous motivation also mediated the associations between psychological needs satisfaction and quality practice frequency ($\beta = .18$, $p < .001$), and preference for challenge ($\beta = .17$, $p < .001$).

Affect

While the requirements of a parsimonious model and the limitations of sample size prevented us from including affect variables in the model, we were still able to examine their relations with the latent constructs. We computed factor scores for the latent variables of needs satisfaction and autonomous motivation, and examined correlations between them and practice behaviours (Table 3). Correlations were observed between affect and needs satisfaction and motivation variables, but not between affect and practice behaviour variables. Table 3 shows that needs satisfaction was positively related to feeling happy, relaxed, excited and proud, and negatively related to feeling nervous. Autonomous motivation was positively linked with feeling happy and excited and negatively linked with proud and unhappy. No relationships were found between affect and practice frequency, quality practice frequency, and preference for challenge.

Discussion

Improving performance ability is amongst the core goals of university music programs, and practice is undoubtedly one of the most important activities for attaining that goal. The present study aimed to model aspects of university music student motivation, and the relationship

Table 3. Pearson correlation coefficients between needs satisfaction, autonomous motivation, practice and affect.

Variables	Psychological needs	Autonomous motivation	Practice frequency	Quality Practice frequency	Preference for challenge
Happy	.38*	.28*	.06	.09	.08
Relaxed	.18*	−.10	−.02	−.03	−.03
Excited	.41*	.29*	.07	.09	.08
Proud	.24*	−.19*	−.04	−.06	−.05
Unhappy	−.06	−.14*	−.03	−.04	−.04
Nervous	−.15*	−.02	−.01	−.01	−.01
Guilty	.05	−.11	−.03	−.04	−.03
Angry	−.03	−.10	−.02	−.03	−.03

Note: $N = 392$.
*$p < .01$.

between motivation and practice frequency, quality practice frequency, and preference for challenge. We confirmed our first hypothesis: music students who perceived that their psychological needs were satisfied by the music environment would have more autonomous motivation towards music. We also confirmed our second hypothesis: autonomous motivation predicted practice frequency, quality practice frequency, and preference for challenge. Students also exhibited positive emotions more frequently, and negative emotions less frequently when their psychological needs were fulfilled and when they were autonomously motivated.

This study was motivated by our interests in several strands in the literature related to motivation and music education. Our first objective was to use SDT to more fully understand motivation for music learning. While motivation for music learning has been researched in the past from a number of angles, SDT's wider lens enabled us to examine a framework for the perceptions of environments and social relationships that are conducive to excellence, learning, and human flourishing. Indeed, we found results that are consistent with the literature on SDT in other areas. Our hypothesis that psychological needs fulfilment in music relates to autonomous motivation reflects findings made by Standage, Duda, and Ntoumanis (2005) in the school physical education context, and also by Niemiec et al. (2006) in the context of college education. The result that autonomy needs satisfaction more strongly predicts autonomous motivation was to be expected, since both aim at increasing or enhancing one's free choices, and is also in line with past research (e.g. Van den Broeck, Vansteenkiste, De Witte, Soenens, & Lens, 2010). Our hypothesis that autonomous motivation in turn predicts adaptive domain-related behaviours is also supported by research. Standage et al. (2005), for example, found that autonomous motivation positively predicted positive affect, concentration, preference for challenge, and negatively predicted negative affect. Extensive research in school education and other education contexts such as university have demonstrated that psychological needs support in these contexts produces greater wellbeing, engagement, and achievement (for reviews, see Niemiec & Ryan, 2009; Reeve & Halusic, 2009).

SDT also appealed to us because there is a clear path towards developing interventions that might be able to improve student motivation and performance outcomes. In educational settings, intervention studies have found that teachers are easily able to learn about how to provide autonomy support and structure within their school classrooms, and when they do, their students experience better feelings of autonomy, greater engagement, and better learning (e.g. Kiemer, Gröschner, Pehmer, & Seidel, 2015; Peetsma & Van der Veen, 2013; Ratelle &

Duchesne, 2014; Reeve & Lee, 2014; for a meta-analysis see Su & Reeve, 2010). University tutors have participated in seminars to learn about autonomy support, and subsequently shown more autonomy-supportive behaviours in their classrooms (McLachlan & Hagger, 2010). Future research in music learning may examine the potential of intervention studies, in which studio teachers learn how to provide autonomy-supportive learning environments for their students. Indeed, Gaunt (2011) observed viable alternatives to the standard one-on-one arrangement in her study where students had several teachers, and as a result, felt a greater sense of autonomy. Potential ways to improve needs support specifically in the context of instrumental music studios are proposed by Evans (2015) and although these remain to be empirically examined, the results of research in other domains is promising.

We prefaced our introduction to this study by situating the importance of music practice within the deliberate practice framework. Deliberate practice as an explanation for expertise is currently under considerable scrutiny, in light of increasing evidence of the contribution of genetic factors to explaining variance in performance. As previously noted, these issues continue to be debated, with some researchers arguing that the emphasis placed on deliberate practice is not justified because the proportion of variance it explains in performance is too low (Hambrick et al., 2014). Others, using more precise definitions of both expertise and deliberate practice, maintain that substantial evidence still exists for deliberate practice as the primary explanation for why some people become experts and others do not (Ericsson, 2014b; Platz, Kopiez, Lehmann, & Wolf, 2014). Regardless of these points of view, practice is the primary activity that is within the student's control for improving performance ability, so its importance as a learning activity for university music students cannot be underrated. Our findings have demonstrated that self-determined motivation and practice are indeed connected, and they suggest that students who are more motivated practice more, and that their practice is more productive. We look forward to the next logical step in this research program, which might uncover how this then relates to progress in students' performance abilities, including using more precise measures of both the quality and quantity of practice. Such research could contribute substantially to the present debate around deliberate practice and expert performance.

We acknowledge some limitations of this study. First, it is difficult to interpret the specific aspects of the environment that affected students' fulfilment of psychological needs and autonomous motivation. We asked students about these aspects of their motivation at the general domain level – the context of their music learning and playing. The response is therefore an amalgamation of the overall aspects of students' engagement with the overall musical domain – studio lessons, their other university classes, their informal music experiences. Further research could measure motivation within more specific situations (e.g. studio teaching) in order to more precisely isolate aspects for which it is feasible to intervene and improve motivation. Second, the total variance explained in our outcome variables (practice frequency, quality practice frequency, and preference for challenge) was not high. We did not expect these R^2 values to be high, since our aim with this study was not to comprehensively model these outcome variables of practice quantity and quality. Rather, our focus was on modelling motivation, and using the outcome variables to examine structural relations. If we had used more proximal measures of motivation (e.g. needs fulfilment while practising; autonomous motivation for practising) we may have seen a greater amount of variance accounted for in the practice outcomes. In addition, further predictive variables related to practice frequency (e.g. Ericsson's effort and resource constraints outlined earlier) and other constructs related to quality practice frequency (e.g. self-regulated learning; McPherson & Renwick, 2011) would increase the variance explained by the practice variables examined here. Thus, any future research aiming to

model practice time and quality more fully would incorporate these other aspects of practice alongside self-determined motivation. Having stated this, however, it is important to note that in practical terms, teachers should be substantially interested in any increase in variance of these behaviours that they can encourage in students. Changing teacher behaviour to be more supportive of psychological needs is relatively easy and low-cost for the teacher (e.g. McLachlan & Hagger, 2010; Su & Reeve, 2010), so there is obvious practical significance of this finding even though the variance accounted for might otherwise be considered low.

Another limitation is the accuracy of measures of practice, which is an ongoing issue in the practice literature, and one of the major keys to refining the deliberate practice debate. Retrospective measures of practice over large periods of time can be terribly inaccurate, due to the limitations of memory. For this reason, we asked students specifically about the last seven days of practice, hoping that this recent window would result in a more accurate self-report. Yet it is difficult to tell whether this worked, and the approach also relies on the assumption that the last seven days was an indicative sample of the average amount of practice the student normally does. Because it seems to be an important variable, future research may examine the viability of experience sampling methods or other means of more accurately and precisely accounting for practice. More developed research methods may also account for different types of practice – conscious, deliberate practice, drilling and technical exercises, and informal play – and thus account for the respective contributions of each type of practice to motivation and performance ability. Such future research could also overcome the present study's sample size limitation.

Conclusion

Clear evidence already exists to show that practice is important to university music student success. It is also well-known that motivation is a critical issue for maintaining practice. This study goes part of the way to address a self-determination theory research agenda connecting the needs fulfilment in the social environment to internalised motivation, and in turn, to practice frequency, quality practice frequency, preference for challenge, and psychological wellbeing. We look forward to future research examining these aspects of music learning in more detail, particularly in relation to refining which types of practice make a difference, and studying these aspects of music learning in relation to performance ability.

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