Applying Self-Regulated Learning and Self-Determination Theory to Optimize the Performance of a Concert Cellist

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The professional practice of classical music performers has been better understood and enhanced across the last two decades through research aimed at tailoring rehearsing strategies that support the development of a sense of self as an agentic and proactive learner. One approach focuses on helping students make use of various tools that can enhance their learning, particularly in terms of what they do, feel and think when practicing and performing music. This study expands literature on expertise development by embracing the idea that this line of research would benefit from additional studies where the researcher forms part of the research process as an active participant who generates data, especially when these researchers are “members” of the social world they study, and therefore have insider knowledge. Thus, this case study is focused on the first author, a professional cellist who is also a researcher in the educational psychology of music, as the only participant. It extends current research by providing a detailed longitudinal mapping of a professional cellist’s preparation across nine profiled concerts in five countries of classical-romantic repertoire and a commercial recording that resulted from 100 weeks of dedicated practice. Anonymous feedback from the audiences and interviews with an expert musician who followed the concerts and the CD recording was also collected. For the data analysis, traditional psychometric measurements were applied to test the internal consistency of the time series data as well as the relationship between variables. In addition, the application of Leximancer analysis of the self-reflections allowed the researchers to probe self-regulated learning (SRL) and self-determination theory (SDT) processes in ways that uniquely mapped, over time, her differing motivations to perform at a high level. Specifically, we report that the cellist’s psychological needs and her motivational resources changed across time within the social context of performing music publicly, and that the various self-regulatory processes she drew upon impacted (both positively and negatively) on her ongoing actions, thoughts and feelings. Implications of the study are relevant for all forms of expertise development research, and especially for understandings about the nature of skill development in the context of learning to perform demanding literature in music.

Keywords: artistic research, intra-individual, learning identity, metacognition, mixed-methods, practice, self-determination theory, self-regulated learning
INTRODUCTION

One way researchers have begun to make significant improvements to the professional practice of classical music performers is through personalized rehearsal strategies that support the development of a sense of self as an agentic, autonomous, and metacognitive learner. The focus of these types of investigations is on improving the various self-regulated learning (SRL) strategies associated with the behaviors (actions), cognition (thoughts), and affect (feelings) musicians employ when practicing and performing music, and that support a proactive engagement with music making and music learning (McPherson and Zimmerman, 2011; McPherson et al., 2019).

Within music, an important theme in SRL research has focused on helping students apply various tools that can enhance their learning (e.g., McPherson et al., 2018, 2019). These self-regulation behaviors that musicians adopt during their performance have been identified as crucial for improving both performance and learning, as evidenced by Pike (2017) in her case study of a piano student, and with a larger number of advanced, skillful music students who have been shown to engage with this type of activity autonomously, especially when practicing their instrument (Papageorgi et al., 2010).

A major component of self-regulation is metacognition, with the cognitive and motivational component of this construct being seen as crucial to optimizing musicians’ practice (Hallam, 2001; Nielsen, 2011) and performance (Concina, 2019). In music, experts have been shown to demonstrate higher levels of metacognitive competence as they self-regulate themselves while learning (Concina, 2019). In addition, self-regulation behaviors appear to be particularly favored by advanced musicians (Araújo, 2016).

Regardless of the level of expertise, the ability to self-direct one’s learning involves three cyclical phases (see Figure 1) in which an individual analyses a task they are about to complete (forethought), employs various self-control and self-observational skills to focus their attention when completing the task (performance), and then makes self-judgments and experiences self-reactions concerning the quality of their efforts in preparation for the next practice session or performance (self-reflection; Zimmerman and Moylan, 2009; Cleary and Zimmerman, 2011; Cleary et al., 2012; McPherson et al., 2018).

Self-regulation has been linked to the efficiency of music practice and seen as vital in the development of musical expertise (Miksza, 2011; McPherson et al., 2019), especially in the context that expert musicians have typically undertaken thousands of hours of practice to refine their craft (Ericsson et al., 1993). The importance of such experience in connection to the development of expert musical performance has been studied by tracking the behaviors of music students during childhood and adolescence while practicing their instruments (e.g., Gabrielson, 1999; McPherson and Davidson, 2002; Miksza, 2006, 2007, 2011; Palmer, 2013), as well as the practice efficiency and dedication of classical musicians (e.g., Gruson, 1988; Sloboda et al., 1996; Lehmann and Ericsson, 1998; Chaffin et al., 2002; Jørgensen, 2002; Williamson, 2004; Altenmüller et al., 2006; Lehmann and Jørgensen, 2012; Jørgensen and Hallam, 2016).

Much of this research has been influenced by the “deliberate practice” framework of Ericsson et al. (1993), which asserts that focused and attentive forms of practice that are cognitively demanding lead to the best outcomes for skill development (see Platz et al., 2014 for meta-analysis). Other lines of research examine how much of the variance is accounted for by practice alone (McNamara et al., 2014; Bonneville-Roussy and Bouffard, 2015) and the motivational dimensions of novice to expert musician’s engagement when practicing (Nielsen, 2011).

Recently, music students’ motivation (Evans and Bonneville-Roussy, 2016), as well as their deliberate practice approach (Hatfield, 2017) have been studied using self-determination theory. Ryan and Deci’s (2017) self-determination theory (SDT) provides a unified theoretical approach to the holistic study of motivation in musicians (Evans, 2015), including the social, cognitive, affective and behavioral factors mentioned above. Self-determination theory plays a crucial role in understanding the six types of motivation, from amotivation to self-determined or intrinsic motivation as the extreme poles (see Figure 2), particularly over extended periods of time (e.g., Georgiadis et al., 2006; Reinboth and Duda, 2006; Sheldon and Krieger, 2007; Alivernini and Lucidi, 2011; Jang et al., 2012).

The various forms of motivation within the SDT model are related to the satisfaction of three fundamental human psychological needs: autonomy (volition, personal choices and decisions), competence (self-efficacy) and relatedness (social connectedness) (Ryan et al., 1995; Hagger et al., 2006). Thus, it is understood that the more these psychological needs are satisfied, the more self-determined autonomous motivation (Deci and Ryan, 2002; Gagné and Deci, 2005; Hagger et al., 2006) and, on the contrary, the more they are thwarted, the more the individual will procrastinate, adopt defensive reactions, and end up feeling demotivated and/or helpless.
Researchers in music have highlighted the importance of intrinsic motivation to overcome difficulties when experiencing failure (e.g., McPherson, 2012). To date, little research has dealt with the intertwined dimensions of self-determination and self-regulation in relation to both practice and performance. Within one-to-one music studio settings (in depth reviews in Küpers et al., 2014; Evans, 2015) these studies have examined the relationship of SRL and SDT with well-being and participation (Creech et al., 2013; Krause et al., 2019), or the frequency and quality of practice in music students (Evans and Bonneville-Roussy, 2016; Schatt, 2018; Valenzuela et al., 2018).

**Rationale and Purpose of the Study**

The purpose of this study was to explore the self-regulatory and self-determination processes of a female concert cellist across 100 weeks of rehearsal as she prepared for a series of concerts and the recording of a commercially available CD. The study sought to examine the professional cellist’s psychological needs satisfaction and various types of motivation in a longitudinal intra-mental process of self-regulation that would optimize the cellist’s performance across profiled concerts and a commercial recording. Key issues included how the musician regulated herself according to the psychological dimensions which underpin intentional self-regulation processes, and how her motivation aligned with her self-reported cognition, behavior, and affect within a social context.

In this regard, the study differs from previous single-case, long-term studies by other authors. For instance, the reports of cellist Tania Lisboa and her colleagues, whose series of research studies have provided invaluable information on musicians-researchers’ subjective experiences of learning music by heart, focused on technical, interpretive, structural and performative aspects such as tempo stability (e.g., Chaffin et al., 2010; Demos et al., 2016). These studies were carried out across public and practice performances with one movement of Bach’s No. 6 Suite for solo cello (ca. 5 min of music) through inconsistent/interrupted data collection procedures. Previously, Chaffin et al. (2002) had similarly studied tempo stability through preparation and performances of one movement of Bach’s Italian Concerto for piano over a period of 57 weeks. Another example of performance tempo variability research is the study by Lehmann and Ericsson (1998) where the authors used a period of 9 months to analyze the development of an advanced piano student from the sight-reading stage to a single public concert performance phase.

To expand on these studies, our study sought to offer new insights into the characteristics of music performance skills of professional classical musicians striving to improve their practice and performance by: (1) expanding the length of time, amount and difficulty of repertoire by including chamber musicianship instead of solo performances; (2) increasing the longitudinal span of data collection to 100 weeks; (3) using original period instruments with a historically informed approach to performance, thus making this study multidisciplinary through the combination of psychology and musicology; (4) employing a mixed methods approach in artistic research; (5) studying not only motoric and cognitive skills development, but also behavior and affect with a special emphasis on intersubjectivity; and (6) focusing on the relationship between SRL and SDT.

**MATERIALS AND METHODS**

A mixed-methods, concurrent triangulation design (see Creswell, 2013) was employed, framed in the art-based educational research (ABER) and creative analytical practices (CAP) to generate practice-based knowledge (for an overview, see
Gouzouasis, 2019). This research approach embraces the view that significant inroads to increasing knowledge in this area may be achieved through studies in which researchers are active participants who generate data as a result of their membership of the social world being studied (e.g., Ellis and Bochner, 2000; Denzin, 2006). The advantages of employing this type of insider knowledge to reinforce research on expertise development is highlighted in recent publications that advocate the use of such mixed-methods approaches in order to “build a rich picture of phenomena exploring subtle social dynamics and interactions between individuals and employing organizations […] trying to understand what is happening, when, and why” (Yardley et al., 2020, p. 412).

A quasi-experimental approach (León and Montero, 2002) examined within-person change and variability through an intervention that consisted of making self-reflections and filling in surveys across concerts and a commercial recording. More specifically, the study examined whether and how such interventions (independent variable effects: concerts and diary interventions) affect the repeated measures of the dependent variable (basic psychological needs), in trajectories of time (pre-, during-, post-rehearsals) and in different stages (concerts, recording).

The self-reflective approach to this study was framed within Boud et al. (2013) three major elements of reflective thought processes of individuals: (1) returning to the experience immediately after the event has finished, to clarify missed details and perceptions; (2) attending to feelings to assess the affective/emotional impact of the event; and (3) re-evaluating the experience to integrate the new knowledge into one’s existing knowledge or repertory of behaviors.

This was complemented by a single-case descriptive approach to describe the intervention in the real-life context in which it occurred (Yin, 2003). For this, the researchers employed a visual inspection approach to make judgments about whether the independent variable was affecting the dependent variable based on level, trend, and latency (Fisch, 2001). This approach helped to reduce the limitations found in retrospective self-report measures that are frequently used in SRL studies (see McPherson et al., 2019).

The Cellist

This single case study was focused on the first author, a professional cellist who is also a researcher in the educational psychology of music. As a female Spanish citizen in her early thirties, now residing in Finland, she is an active professional musician with a Master’s Degree in Cello Performance who specializes in solo recitals and chamber music concerts on period instruments, and whose concerts and recordings have been critically acclaimed internationally. In addition, the participant-researcher has obtained a Ph.D. in Psychology, having specialized in social constructivism (psychological school) in music teaching and learning.

Procedures

The study investigated the intra-individual change and variability in intentional self-regulation through the researcher’s learning of canonic Classical-Romantic era works for the instrumentation combination of cello and piano, as she optimized her performances over a period of 100 weeks (from 29/7/2016 to 19/10/2018) across 9 invited profiled concerts in 5 countries (see below) and a commercial CD recording (Complete Mendelssohn Piano and Cello Works on Period Instruments, Alba Records, ABCD434, 2018). During this time, she learnt and performed the following pieces by Beethoven and Mendelssohn—all considered artistically demanding because of their stylistic and technical demands. This repertoire comprised a total of 150 min of music.

Repertoire

Ludwig van Beethoven (1770–1827):

- Sonata Op. 5. No.1 in F major (1796)
- Sonata Op. 5. No.2 in G minor (1796)
- 12 Variations WoO45 in G major (1796)
- 12 Variations Op. 66 in F major (1796)
- 7 Variations WoO46 in E-flat major (1801)

Felix Mendelssohn Bartholdy (1809–1847):

- Variations Concertantes Op. 17 in D major (1829)
- Albumblatt (Assai Tranquilo) in B minor (1835)
- Sonata Op. 45. N.1 in B flat major (1838)
- Sonata Op. 58. N.2 in D major (1843)
- Lied ohne Worte Op. 109 in D major (1845)

Concerts

(1) October 2016. Sellosali Concert Series, Espoo (FI)
(2) November 2016. Theatrum Kloostri Ait, Tallin (EST)
(3) May 2017. Nordic Historical Keyboard Festival, Kuopio (FI)
(4) September 2017. Aino Ackté Festival, Helsinki (FI)
(5) November 2017. New Pavillion Concert Series, Kauniainen (FI)
(6) April 2018. Beethoven Research Center, San José (US)
(7) July 2018. Piano Salon Christophori, Berlin (GE)
(8) August 2018. BRQ Vantaa Festival, Vantaa (FI)
(9) October 2018. Moscow Philharmonic Society Small Hall, Moscow (RU).

Forms of Data

For the purpose of the analyses reported here, forethought data included:

- Printed sheets including questions with dichotomous and Likert-type scales related to the types of motivation described previously. The sheets included descriptions and examples of the six types of motivations to cue the cellist’s self-reports before practicing, as follows:
  - Intrinsic Motivation (enjoyment, pleasure, internal, process oriented): Today, I am studying because I think the task/goal/piece is interesting and I like/enjoy the learning process (Scores from 1 to 10—less to more)
  - External Regulation (external pressures, operant conditioning): Today, I am studying because I want to do well on the next concert/rehearsal with pianist, or because
I want to gain trait/rewards/success or avoid punishment (Scores from 1 to 10—less to more)

- Integrated Regulation (coherent personal behaviors to achieve the goal): Today, I can remain calm when facing learning difficulties because I can rely on my abilities and adopt the necessary behaviors (Options: yes/no/partly)
- Identified Regulation (value of the outcome, learning what needed): Today, I have a fierce desire to overcome obstacles or challenges that lie within today’s task/goal/piece no matter what (Options: yes/no/partly)
- Introjected Regulation (internal pressures, ego): Today, I feel I would need feedback/approval from a professional or from other people because I am stuck/under pressure with the task/goal/piece and do not know what to do (Options: yes/no/partly)
- Amotivation (completely unmotivated): Today, I have no interest/intention to practice and will do nothing to change this situation (Options: yes/no).

All inventories were adapted from the theoretical models by the researchers. Validity and reliability of the measurement techniques were provided by: (1) defining preliminary questions and the types of possible answers in relation to the six types of motivations for the instrumental music domain with the support of an expert in self-regulation studies who possesses expertise in developing and validating questionnaires and rubrics within the field of learning sciences; (2) piloting the questions during 5 consecutive practicing days approximately 3 months before submitting the research proposal to carry out this project (which was subsequently funded); (3) refining independently subtle aspects in the questions and answers that arose during the pilot of the measurements; and (4) using the theoretical model to add descriptions and examples independently.

For the self-reflection phase, data consisted of:

- The same questions, including dichotomous and Likert-type scales, as in the forethought phase (though adapted by using past tense as they were referring to the immediate finished practice session) so that the cellist could self-report about her motivation after practicing.
- Personal self-reflections in English and Spanish in which the cellist described her actions, thoughts and feelings during the particular practicing session and overall week connected to it.
- Feedback from the audience and concert/CD critics (see Supplementary Appendix 2).
- Comments from an independent expert (see Supplementary Appendix 3) who listened to all concerts either live or via high quality video in order to provide an independent external assessment of the overall artistic value and quality of each performance and the resultant CD recording.

Processing of Data

The above data was collected approximately once a week, on average, and both the exact practicing days and the selected repertoire per concert are provided in Supplementary Appendix 1. The amount of accumulated practice time for each of the reported days in this study ranged from 40 to 100 min per session ($M = 65$ min). The cellist did not gather information on accumulated practice during other practicing days where there were no diaries involved. However, her total practice estimation during the whole artistic project was approximately five times more, as she kept a regular practicing routine that ensures she practiced at least 6 days a week.

Data preparation was undertaken from source document (printed sheets) to machine readable form (computer files) then edited or translated as necessary prior to the analyses. Source documents were stored in a locked file cabinet. Computer files were saved in the internal hard disk of a computer with password and as a backup in an external hard disk with the password kept within a locked cabinet. Data integrity was measured in terms of accuracy, timeliness and relevance, as it was transcribed immediately and systematically after each data collection point. At the time this article was published, data was not available in any open data repository.

Performance Approach

As a cellist, the first author specializes in historically informed performance practice (HIPPP), and her performances were informed by a musicological approach that included visiting sites where the original and copyist manuscripts of the music to be performed and other miscellanea related to the composers were located. These included the Bodleian Library in Oxford, the Staatsbibliothek zu Berlin, the Heinrich Heine Institute of Düsseldorf, the Biblioteka Jagiellonska in Krakow, the Mendelssohn-Haus in Leipzig, and the American Research Center in San José, California (for more information, see López-Íñiguez, 2019a,b).

Cello and Bows

A cello by Claude Pieray (built in Paris, 1725) with an instrumental set-up inspired by examples from the early 19th century, and classical-transitional bows by François Tourte (built in Paris, 1800) and by André Klaassen (built in Zutphen, 2015) were used for all rehearsals and performances. The first two tools have been loaned to the performer for lifetime by a private donor, whilst the third is her own property.

Pianists and Keyboards

For this research project, the cellist was accompanied by three different professional pianists in both modern and period keyboards, who performed on romantic pianos and fortepianos (the detailed list of these particular instruments can also be found in Supplementary Appendix 1).

Analyses

We performed a linear regression on the overall dependent variable motivation against both independent variables concerts (understanding concert as a continuous variable on a scale from 1 to 10 study sessions) and intervention (pretest versus posttest).
In order to quantify and display the conceptual structure of the open questions in the diaries, and explore conceptual features over time, we also used the content analysis tool LEXIMANCER (2018). This approach was employed because it reduces the bias that can potentially occur when researchers code or categorize their own data, even after using reliability procedures involving other experts, and to ensure through a complex network analysis that the researchers do not become fixated on certain concepts to the detriment of others (see section “Post-Practice Self-Reflections, Leximancer Analysis” for further details).

RESULTS

The following sections include descriptive statistics for the Likert and dichotomous questions regarding the five types of motivation1, as well as linear regression results. We also include a section that provides the Leximancer analysis of the self-reflections across concerts.

Five Types of Motivation

Figure 3 shows the visual tendency according to the scores (from 1 to 10 points) assigned to the questions based on Likert-type rating scales for intrinsic and external regulation across concerts (10 practicing sessions per concert). The scores can be observed in Supplementary Appendix 4.

Figure 4 shows the visual tendency according to the dichotomous questions (yes/no/partly) for the subtypes of extrinsic motivation, namely integrated-identified-introjected regulations across concerts (10 practicing sessions per concert). The scores are shown in Supplementary Appendix 4.

Effect of Intervention and Concert on Motivation

A linear regression on the same items was employed to test significant differences in the motivation items pre- and post-intervention and after all concerts. For each motivation and regulation type, the pretest and posttest scores were plotted against concert, to display the scores and help assess the pretest versus posttest difference. A linear regression was performed against concert, to display the scores and help assess the pretest versus posttest difference. Regression coefficients were estimated along with their associated standard errors, and P-values calculated to test the significance of the coefficients (see Table 1).

As shown in Figure 3, there was a clear increase of intrinsic motivation throughout all concerts while external regulation decreased. According to all concerts and the 10 rehearsals sessions within each concert, a linear regression found significant differences in these two types of motivation pre- and post-intervention and after all concerts (see Table 1).

Figure 4 showed that integrated, identified and introjected regulations increased markedly during the project. A linear regression on these three same items found significant differences pre- and post-intervention and after all concerts only for identified regulation what comes to study sessions' progress within a concert (see Table 1).

In order to understand how these particular aspects of motivation shaped the cellist’s practice sessions and the underlying reasons for her self-determined motivation, the following section includes an analysis of the musician’s post-practice self-reflections where she describes her actions, thoughts and feelings.

Post-practice Self-Reflections, Leximancer Analysis

In order to explore conceptual features over time in the self-reflections after each concert (including 10 practice sessions each), we applied a leximetrical analysis—with the help of an expert user of this software—employing the standard granularity threshold of 100% for visible concepts and 50% for theme size (concepts), and a basic conglomerate of related words (thesaurus). For example, using this system practiced and practicing would go under the concept of practice; with player, performer, cellist and musician under the concept of musician. Leximancer is:

“[a] method for transforming lexical co-occurrence information from natural language into semantic patterns in an unsupervised manner. It employs two stages of co-occurrence information extraction—semantic and relational—using a different algorithm for each stage. The algorithms used are statistical, but they employ non-linear dynamics and machine learning” (Smith and Humphreys, 2006, p. 29).

Leximancer software uses a combination of techniques such as Bayesian statistics that records segments of text to identify semantic concepts. Then, it associates those concepts to a thesaurus of words that provide each concept with their definitional properties.

In the next sub-sections, we followed the common practice in leximetrical studies (e.g., Bécue-Bertaut, 2010) by using bold for emphasis of the main semantic concepts identified during the analysis as per their relative frequency, strength, and prominence. Provided below are the prototypical phrases that support the main concepts selected by this tool per concert (see Figures 5–13). The selected phrases are introduced in order (from earlier to later diaries within one concert). We have included a narrative description of the aspects featured in all stages at the end of this section.

Concert 1

“I have to prepare my body better before practicing. Difficult things will be better tomorrow.”

“I would need more knowledge about HIPP [Historically Informed Performance Practice] to frame my practice particularly toward misunderstood Mendelssohn’s pieces.”

“The worst part is to be mentally ready to play with the pianist, so that I feel strong on stage. She is too patronizing during rehearsals. I need better people to support me in this project.”

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1Amotivation has not been included in these results because the cellist never assigned a response for it.
"I tried to widen the emotional range of each variation and the character contrast between each variation. I need to work on technical issues to play the music by Beethoven more fluently. I need more time in general."

"I was extremely nervous in the concert. I invited too many important people and some musicians-colleagues, and that plus the attitude of my pianist during all the rehearsals preparing for this concert made me feel crazy, so I could not focus well for the practicing time prior to the concert, it was a bit of nonsense, besides my energy was really low, my hands tired."

Concert 2

"Today I was going through both Beethoven-Variations, thinking of how to improve the phrasing, to make it more natural and flexible, more singing, but also more fluid because even if I can play all the notes right, it doesn’t carry well. I was trying to play them with more relaxed body, with a different bow, changing some fingerings and bowings for the less physically demanding solutions, and things like that, but it is not as it should be."

"I was trying to work on the sudden virtuoso places of the Beethoven-Variations, because you jump from playing the simplest basso continuo line to the most virtuoso passage, so I was trying to have breaks and jump suddenly into the difficult passages, and that was useful."

"The next concert is radio-broadcasted, so I have to perfect my tone quality, even if it usually is good, but make all changes of positions and bowings smoother and cleaner, so I was doing a bit of that too, because it needs a very special atmosphere, so I tried different ways to express the emotions behind the music."

TABLE 1 | Effect of intervention and concert on motivation.

|                          | p Intervention | β Intervention | SE Intervention | p Concert | β Concert | SE Concert |
|--------------------------|----------------|---------------|-----------------|-----------|-----------|-----------|
| Intrinsic Motivation     | 0.000          | −0.630        | 0.148           | 0.000     | 0.214     | 0.026     |
| Integrated Regulation    | 0.064          | −0.210        | 0.108           | 0.000     | 0.111     | 0.019     |
| Identified Regulation    | 0.013          | −0.290        | 0.116           | 0.000     | 0.120     | 0.020     |
| Introjected Regulation   | 0.065          | −0.200        | 0.108           | 0.000     | 0.118     | 0.019     |
| External Regulation      | 0.000          | 1.030         | 0.140           | 0.000     | −0.236    | 0.024     |
"I have been thinking a lot about the ways to feel more secure with the pianist, and the only way is to avoid talking about anything, and just play and focus on the pieces, so I was working on a better rehearsal plan, and the things that I would like to improve, as well as more chamber musicianship, more connection between us, not just playing together."

"Today I focused on connecting the movements of the Beethoven-Sonata in a way that the piece is a whole, and not a package of different movements. I was making sure the tempi relations were organic, and I was trying to understand the logic behind them, because for the first concert I just did what everyone does, but this time I tried to look beyond and see what the tempo giusto for this music could be, I tried different types of tempo relations, and also of speed for each movement, till I found some nice solutions which I marked with the pencil on the score. I want to make sure during the next times that these tempo relations seem organic most of the times, so that I make them somehow the final version for my performances."

"I was today comparing the performance of these Beethoven-Sonata and Beethoven-Variations with the modern-cello and the period-cello, and it was very revelatory. I tried to perform the pieces as a modern cellist would nowadays, and then compare that with the HIPP approach, and it led to very interesting performative conclusions."

"I was thinking about how did the bowings feel in the previous concert, so I tried to make a compromise between the perfect style and a comfortable enough performance, physically speaking."

"Today I decided to think positively about myself and my playing, and about the possibility to succeed in the coming concert."

**Concert 3**

"I have tried to focus on the new Beethoven-Sonata, this will be the first time I play this one, and I wanted to dedicate extra
FIGURE 6 | Leximancer concept map for Concert 2.

FIGURE 7 | Leximancer concept map for Concert 3.
time for this piece this week. It feels a little easier than the other Beethoven-Sonata, yet there are a few tricky passages, so I was working on them. It is also a very idiomatic piece, so I quickly found easier solutions for fingerings and bowings which follow the same HIPP logic as the ones I have used in the other pieces by Beethoven, so this was a lot faster process than before, as I am learning the language for this music.”

“I will repeat the same kind of work for some days, to get used to it and learn the pieces better and better by reflecting on the physical feelings when I do such work, so that the body memorizes the movements and feelings for the concert.”

“I was practicing today before my rehearsal with the pianist, and I wanted to save some energy because every time I meet this person I run out of energy, and I need a lot of mental strength to go through the rehearsals. Others’ limitations are not my limitations, so I was focusing meticulously on what I am doing during the practice, like in a laboratory.”

“I want this piece to sound perfect, because I love it, so I was a little stressed out in the exercises I did with some passages, wanting quick results, so I have to be more patient and learn progressively. I cannot demand quick results if I really want to know the piece well and own it. I’m learning to focus better during my sessions, these diaries seem to help, so I’m more reflective when I choose what to do, and particularly how not to procrastinate or think about something else while I practice. I have set my phone off during my practice, and that is really good too, and I have been doing more Yoga.”

“I have less than three weeks before the concert, so it should be ok to have a day off and just sleep well and rest, because I see no point to practice with this lack of focus and body pain, and tiredness after the whole academic year and traveling all the time, yet, I tried my best to practice focusing on what I wanted to learn and develop, to maintain the muscle engagement, so that my strength develops progressively.”

Concert 4

“As I have enough time before the next concert and I’m on holiday, I can focus to practice specific passages without playing the pieces through and try to truly develop and improve the places that need more time, so I was focusing exclusively to those passages that are still in progress. Really good work.”

“Today I felt I need to play the Mendelssohn-Sonata really well and memorize it a bit better.”

“Today I wanted to compare the HIPP approaches to the Beethoven-Sonata and the Mendelssohn-Sonata. I wanted to analyze and learn what performative and technical aspects are similar and different, so that I am more aware of these aspects...
when I perform, and make them even more clear for the audience, and for the pianist.”

“Today I was determined to check the density of the piano parts, which also gave me a good idea of where I could do even more artistic and creative things, and when there is enough space for improvising in different ways with the tempo, the rubato, the rhythmic asynchrony, the portamenti, etc.”

“I did a great warm up today, the child is at school and I don’t have teaching yet, so I had plenty of time to practice, with enough breaks, some tea time, some stretching, some relaxation, a great and long warm up, and breathing and technical exercises. Then, I went into the most demanding passages in each piece for this program, and I really felt I have progressed and learnt a great deal about this music, yet the work is not finished yet, so I must keep on to honor the music.”

“I try to save some energy for the concert, so I was thinking how to share the muscle strength and mental energy between Beethoven and Mendelssohn in the concert, so that I am not exhausted at the end, as this is the longest concert we will have played so far for this project, so this is important.”

**Concert 5**

“I did a great practicing session because I focused exclusively to see the development of Mendelssohn’s styles across the whole concert program, all his music for cello and piano, and that was a really interesting and inspiring strategy which kept me working despite being exhausted and with a little neck tension and back and shoulder plate pain. I think I will work on this style thing during the next days, as I feel I need to learn much more about the shuttle differences in the complete music.”

“Today I was extremely happy and motivated to practice because I changed my pianist for a much proficient pianist, and also a more relaxed person, I had the first rehearsal with her today, and the chemistry was immediate, besides I could play some difficult stuff in an easier way because the pianist was able to play her parts without problem and understood the tempi and character in a similar way as I do. I am really happy, motivated, and feeling more and more confident. I basically enjoyed playing the pieces through without the mental turmoil I have experienced so far. I felt relieved and wanted to only focus on positive playing experiences in my study today, to recover from the negative past.”

“I have played the Mendelssohn-Sonatas so much that today I wanted to focus exclusively on the smaller Mendelssohn-Albümblatt and Mendelssohn-Romance. It was lovely to work on them as they are so different in the character. They are not technically impossible, so I tried to be as polished as possible, making them perfect technically and stylistically, without losing the passion and character, or being uninteresting. They are so short that I played them through several times, and I am to do the same in the next days because these are the pieces that the
Today I worked on the different characters and intonation issues according to the keys and harmony of the Mendelssohn-Sonatas. They are really different and they both take a lot of energy, so I was trying to build interesting moments to keep the tension and emotional engagement of the audience through them. I just love working on these pieces.

Today I was video-recording my practice, which I should do more often. I have been so bored practicing these pieces over and over again, even if I love them, that I did not know what else I could do. I watched the video of the run through the whole concert program and got several ideas for improvement.

Today I had a good day because I got big funding for the Mendelssohn CD recording, which gave me a lot in encouragement and eagerness to practice and dream about the whole thing. I was really motivated and happy, and I did a great job despite being tired and again with wrist and neck pain.

I tried to play the later repertoire by Beethoven in order to make even more clear the characters and technical aesthetics of the earlier music. I spent several hours doing this because it was a rather reflective work, and I needed lots of time to think about what I was doing and if it made any sense, but it did and I learnt a lot. I enjoy much more playing the earlier pieces, and I was thinking about the aspects I want to mention in my program notes to the audience.
“I did some intonation work with the tuning machine, and some Starker, and I moved to the Beethoven Sonatas, just trying to play the pieces by heart, which went rather well. I feel I own the pieces now, and that the long break was actually needed to avoid artistic and physical burnout.”

“Today I recorded my practice, to see how the clarity of my playing is, and how clean the virtuoso passages sound. I wanted to prepare well before I go to the United States and meet the new pianist, so that I can enjoy the rehearsals as much as possible. I was visualizing a positive relationship with the pianist, and a successful concert experience while playing the program through, while trying to breathe and relax the body right before the virtuoso passages, so that I am really in control.”

Concert 7

“I have done some mental work today. I have decided to practice the concert in a different way than the recording sessions, as the audience is a different thing than a microphone, and that playing 90 min recital needs a different energy optimization than an 8-h recording session with snacks and indoors all day. So, I just focused on getting back to the program.”

“I think I need a period of working with the left hand enough, because that is my weakest part, and it needs still some muscle strength and confidence.”

“I practiced the simpler Mendelssohn Pieces, trying to reach a great sound quality and expression, without any technical mistake, yet with lots of singing qualities, until I was pleased.”

“Today I recorded my practice, just without playing the concert through, only a regular practice, because I’m so bored of this program, that I wanted to see what I could do to inspire myself, and toward what kind of direction I could move. I noticed that I play too much without enough breaks, even if it seems that I am stopping, so I should be even more conscious on how I schedule my practicing sessions, probably using a timer, though it is demanding for me as I am quite a free person what comes to time use.”

“Today I just played through the pieces, work slowly on a few passages that gave me a headache before, and video-recorded the session, which was useful as I noticed some issues with my right arm position and use, which seems to be less relaxed than I wish, even though I had not felt any problem while playing.”
FIGURE 12 | Leximancer concept map for Concert 8.

FIGURE 13 | Leximancer concept map for Concert 9.
Concert 8

“I had no eagerness to play the same music over and over again today, it gets tired when you have practiced it for so long, that musical ideas do not appear anymore. So, instead of doing the usual work, I was reading the score in peace without the instrument, just making sure I know every single annotation by the composer, and I also spent some time playing the music with the modern cello, to remember the physical differences, and the artistic options I have with a period cello. I think I need a little break for a couple of days and play something else to avoid hating this music.”

“Today, I did not play the Mendelssohn repertoire at all. Instead, I did the longest warm up ever, and I played some etudes and exercises from relevant treatises, which felt good and refreshing. I just wanted to make sure I still love my cello after this long project.”

“Today I did two run throughs of the program. One focusing to relax the body and breath, and the other one focusing to exaggerate the character of the pieces. This was a wonderful exercise because, technically, I feel ready, so I enjoyed myself a lot.”

“I decided to spend the day playing everything slowly in my mind first, in the order of the concert. It was really exhausting, but super useful, as when I started to play the cello, many things felt really fluent, I should do this exercise more often as it is less physically demanding, yet one learns a lot. I also thought about all the journey with the learning of Mendelssohn’s music, and how far I have reached, yet how much more one could learn and how many stylistic aspects are unclear for performers, so I tried to focus to the ones that I really feel secure and confident about, and play them really clear.”

“Today we practiced in the concert venue both individually and together, we had a good time there as this venue has the perfect acoustic for this kind of music, intimate and helping the balance and overtones, so I really enjoyed myself focusing on the harmonics and resonance of the instruments, and how easy it was to play in tune with the fortepiano, that everything was in the right place. I think I should go for better acoustic places because this is a crucial aspect to keep happy.”

Concert 9

“I have got some physical strength and my fingers and arms feel stronger, so the practicing takes less energy.”

“Today, I played the program through three times. I wanted to make sure that I am able to do so, therefore I will feel really strong and powerful when I only have to play it once during the concert.”

“I know myself better according to my mood, mental and physical situation, energy levels, focus, situation of the instrument ant the people I play with, and I am not sure what to write anymore, except that I am faster solving any issue that has to be fixed with this repertoire.”

“Today I focused on only one thing that has kept me happy during the last days, which is to enjoy practicing as much as possible, without any specific work plan beyond playing musically and in a confident manner, with a relaxed body and a calm mind. Just performing cello music for myself.”

“I am not sure what else I could try out at this point after so many concerts and the recording preparation, somehow, I feel I need new repertoire and style, and have a good holiday.”

Description of the Aspects Featured in All Stages

Concert 1 involved aspects such as body control and technical development to tackle part of the repertoire, setting up a routine to practice, starting the first HIPP and emotional connections of the music with the instrument playing, and realizing the external pressure due to the first professional concert situation and the negative connection with the pianist.

In Concert 2 the cellist became more strategical in her practice toward refining the emotions and technical clarity in the pieces, particularly working toward a radio broadcast for the second concert. She endeavored to establish a positive mindset after reflecting on how the previous concert went and adopting more complex strategies for the HIPP style through the use of different instruments. Continuity of the music as a holistic conception of performance was also worked out in relation to phrasing and tempi. Dealing with the pianist was thought out carefully by means of preparing mentally prior to rehearsals and avoiding verbal communication in order to survive the situation.

Concert 3 dealt with the application of different solutions to new part of the repertoire based on the previous concerts and pieces in connection to muscle memory and identifying problems from the beginning to avoid losing time, which led to quicker learning. Mental preparation before rehearsals with the pianist to avoid low energy and negative feelings was also considered. Conditions for practicing such as avoiding the use of electronic devices, preparing the body better through physical exercise, resting when exhausted, and becoming more reflexive when preparing the study sessions were crucial in this stage.

Concert 4 involved working with more selected passages, memorizing the music, and comparing the different technical aesthetics for Beethoven and Mendelssohn, while keeping the pianist and audience in mind to convey these aspects clearly. In addition, a more creative and improvisatory focus than in previous concerts stages was adopted, including the organizing of practicing sessions in a better fashion (breaks, warming up), including mental and body awareness to cope with the concert demands.

Concert 5 included work on more subtle differences within a composer’s style, refining the music making, saving energy for the concert, and enjoying having a more supportive and proficient pianist than previously. Focusing on the cellist’s own enjoyment of the music playing while practicing, thinking about communicating them to the audience and honoring the composer were also considered. Using video-camera to provide feedback on how to improve further was a useful strategy, and external funding proved to make a difference in the cellist’s overall mood at this stage of the artistic project.

Concert 6 dealt with the emotional engagement with the music and perfecting even more the technical aspects in selected
passages, becoming more reflective and organized with the practice, and preparing mentally in a positive way for a concert with another pianist.

Concert 7 aimed to build more muscle strength through selected exercises to cope with a more demanding concert and the recording, putting more focus on expression than on technical aspects, and thinking about how to improve the practice sessions’ overall structure for time optimization. Awareness of body tensions through video-camera was also considered.

For Concert 8, reading the scores and mental practice, plus a variation of practicing strategies due to tiredness of practicing the same repertoire in similar ways with the instrument for so long were employed. Becoming more confident, enjoying the concert venue, and focusing on the performance were at the center of this preparation.

Concert 9 was about rejoicing practicing and preparing positively for the performance, whilst recognizing the development throughout the project in relation to body control and muscle strength, ownership of the repertoire and the instrument, and confidence as a performer who is also looking toward future artistic projects.

DISCUSSION

This study examined the self-regulatory and self-determined processes of a single professional cellist across a period of 100 weeks, as she prepared for performances and a commercial recording. It sought to understand how the cellist’s psychological needs and motivational resources changed across time, and how her behavior, cognition and affect within the social context of performing music publicly was aligned to her use of various self-regulatory processes that impacted (both positively and negatively) her ongoing actions, thoughts and feelings.

The cellist is a professional musician and concert cellist who was capable of undertaking this study as a single participant due to external funding to carry out an artistic research project of this kind, and also having the technical resources and knowledge to prepare the research design described above. She was capable of devising specific goals for her practice, and approaching tasks strategically, particularly in terms of assessing her future success and failure. She also possessed clear artistic career intentions that were evident throughout the project and especially during the performance that culminated in a commercial recording of the literature she prepared. Finally, her strong intrinsic motivational orientation and desired to be autonomous and personally competent formed the basis from which she was able to continuously monitor her practice and choose behaviors that would support her in achieving her goals, particularly by feeling and thinking more positively about herself and her own learning.

There are several factors that helped the cellist in her performance and learning optimization development across the study. On the one hand, there was a clear increase of intrinsic motivation throughout all concerts while external regulation decreased. According to all concerts and the 10 rehearsals sessions within each concert, significant differences were found in these two types of motivation pre- and post-intervention and after all concerts. The cellist explains this in connection to two main factors: (1) the change of pianist for a more supportive one and improving her overall conditions for the project (mental and physical work, better concert venues and instruments), and (2) the desire to become more autonomous, confident, and competent both technically and artistically. This shift toward more specific and intrinsically rewarding music objectives and focused practice as the project developed is consistent with reports from studies dealing with tertiary music students’ practice, where SRL instruction has been used to change traditional learning approaches (Miksza, 2015).

On the other hand, integrated, identified and introjected regulations increased markedly during the project. Significant differences were found as per each concert and all study sessions within a concert, whereas differences pre- and post-intervention and after all concerts were only found for identified regulation what comes to study sessions’ progress within a concert. The results concerning integrated and identified regulation align with the cellist’s continuous desire to learn the necessary skills to succeed in each concert according to her predetermined goals. At the same time, the overall increase in these types of regulations after each concert can be explained because the cellist wanted to avoid external disapproval and achieve her outcomes, even if sometimes she relied on internal pressure to achieve this due to the importance of the project for her and, for example, time and conditions constrains to make it happen—thus keeping a professional attitude for both rehearsals and performances as she focused her attention on preparing for quality concerts. Additionally, the feedback from critics, audience and the expert musician who attended the concerts—generally positive and encouraging—as well as the external funding received during the project, could be linked to the increase of, particularly, introjected regulation, as these narratives were regularly appearing while the cellist was rehearsing in the studio or performing publicly, and therefore extrinsically influencing her learning processes. However, as might be expected through extrinsic forms of motivation, their importance can be interpreted as less influential since they did not appear in the Leximancer analysis.

Overall, this continuous engagement in self-monitoring and self-observation of behavior across the period studied led to an increase in the cellist’s metacognitive ability to apply more progressively complex rehearsal strategies. For instance, as described in section “Description of the aspects featured in all stages,” the cellist monitored her learning by:

- drawing together more complex connections among artistic and aesthetic ideas: for example, from trying out the first HIPP ideas to being able to apply a selection of them after reflecting which ones better suited her style and the music;
- using information in new situations: for example, assessing how concerts went and how further improvements could be made in future concerts, in addition to reflecting on what comes to kinesthetic and muscle memory or dealing with external pressure and selecting a supporting pianist; and
attributing success and failure and planning tasks accordingly: for example, from being less organized in the study and feeling constant musculoskeletal pain to creating regular habits for mental and physical practice.

She acknowledged that her constant responses on the printed sheets throughout the project cued her desired development as per a choreography of learning habits, strategies, and abilities that she had developed across her entire musical development (McPherson et al., 2019). This also shaped the way she pursued and refined her own identity as a learner (Coll and Falsafi, 2010)—a type of learning mindset that has recently been associated with musicians' career success and enjoyment (López-Íñiguez and Bennett, 2020)—, in ways that allowed her to thrive motivationally (Ryan and Deci, 2002).

The cellist's self-determined motivation was studied through a lexicometrical analysis of how relatedness, competence and autonomy acted to increase or decrease motivation by means of more progressive complexity in all stages of preparation. Prototypical phrases selected by the Leximancer software across concerts showed that during rehearsals, the cellist was constantly improving on (1) her technical and strategical learning processes, (2) her mental preparation before concerts, rehearsals with pianists and individual study sessions, (3) her body awareness and physical development as per muscle strength and energy; (4) the conditions that affected all stages, such as different pianists, venue acoustics, type of audience, broadcasting, funding and praise, and (5) her short- and long-term artistic goals.

Our analyses highlight strategies that the cellist adopted to optimize her learning and performance in preparation for concerts and a CD recording. Many of the aspects are also present across the entire life of a musician, such as striving for technical proficiency through progressive muscle development, employing a particular style to a certain repertoire, or working on mental preparation and memory processes. There are, however, a number of aspects inherent in this 100-week preparation cycle that the cellist has not previously experienced for other artistic projects. These include (1) understanding how emotional and professional support from peers is crucial for feeling competent and thriving, (2) working on more creative, stylistic, and improvisatory aspects of music making, particularly in terms of the canon repertoire, to help select better strategies for learning and performances fresh and unique, (3) using video-recording study sessions and rehearsals to better inform the path to a desired outcome, and (4) taking care of the body as a fundamental aspect in the life of a performing musician.

Systematically organizing her own thoughts, feelings and actions in connection to her learning and performance goals, helped the cellist to balance the quality and quantity of practice undertaken during the period of preparation. For instance, working on mental preparation and physical strength, changing her first pianist for a more supportive one, continuously focusing on improving technical and expressive-aesthetic aspects of the repertoire, and becoming more selective with her practicing strategies and the conditions of the study sessions leading up to a series of successful concerts and commercial recording (in line with Usher and Schunk, 2018) ensured that external feedback provided triangulation of the data (contradicting versus supporting).

In fact, the external feedback supported her personal understanding of the overall quality of the project, and that thought by other people, for the solely purpose of being as realistic as possible with regard to the artistic outcomes of the project and its legitimacy in the research field of musical expertise. Overall, she was confident in the quality of her performances, particularly from the fourth concert, and enjoyed pushing herself to work hard and collect the data. This project included music close to her heart that she wanted to perform at a higher level than previously through the use of self-regulation materials and a better understanding of how human motivation functions in her particular case. In fact, she perceived that engaging in self-regulation made her feel more efficient in her practice and experiencing progressively more flow while practicing and performing. This led her to accomplish a number of short- and long-term goals, as has been reported in other research using music students (Miksza and Tan, 2015).

Our results can also be related to the fulfillment of the cellist's psychological needs. This aligns with previous research in which such satisfaction of needs has been related to autonomous motivation (in music, Evans and Bonville-Roussy, 2016; in other educational contexts, Standage et al., 2005; Niemiec et al., 2006). However, the negative experiences described when playing with one of the pianists of the project was clearly a demotivator for her. In this regard, a supportive environment—from both other pianists and the praise from experts, public and critics—has been associated with better well-being (in healthcare. Deci and Ryan, 1987; Ferrand et al., 2014; in music education, Krause et al., 2019) and engaging in SRL led the cellist to take action and change this situation. This led to higher levels of enjoyment, engagement, performance, and self-determined motivation, as well as higher perceptions of musical competence—all aspects that could be understood as educational implications to better support students in the fulfillment of their basic psychological needs (Ryan and Deci, 2019).

This study has a number of methodological implications. It documents an innovative research intervention and analysis not employed before in self-regulation studies in music: intentional self-regulation and time-series analysis in music by a musician-researcher who was researching herself. This is also one of the first times that Leximancer analysis has been employed in a music study. Thus, the current study expands the positivist and post-positivist research paradigms (Denzin and Lincoln, 2000) common to the literature on self-regulation and self-determination theories. The study also contributes to the enhancement of more realist, positivist approaches to the field of artistic research where artists research themselves by rigorously merging the eternal divide of theory and practice through a multiplicity of research methods and domain-specific expertise (artistic, psychological). This combined approach is based on the assumption that:
“[. . .] there is no single external reality or, if there is, then it can never be fully and completely defined—as human nature is to view it through a complex set of pre-existing beliefs and experience. Phenomena, therefore, exist as conceptualized by different people. Different researchers, or even the same researcher on different occasions, can apprehend them in different but equally valid ways. Subjectivity is inherent to qualitative research and, if deliberatively applied to qualitative analysis, an asset rather than a problem. Rather than proving the existence of phenomena and measuring how those phenomena vary, qualitative research provides rich representations of phenomena” [in line with Crotty (1998) as mentioned in Yardley et al., 2020, pp. 413–414].

In addition, we are aware that there are other motivational aspects that affect a musician’s practice. Because of this, our ongoing research plans to target the role of academic emotions (as enumerated by Pekrun et al., 2002), quantity and quality of practice (following Ericsson et al., 1993), and the use of learning conditions, processes and results (in line with the model proposed by Pozo et al., 2020) during her practice. Such work will provide a holistic picture of the psychological aspects behind the practice of expert musicians.

We recognize that the study reported here has certain limitations. First, it is restricted to a sample of a single cellist and therefore the results obtained are difficult to generalize to other professional musicians. However, the implications of the use of these reflective materials on the increase of intrinsic motivation and decrease of extrinsic motivation in the cellist across time could be replicated in other longitudinal studies of professional musicians within the classical genre and those of other genres that strive for such outcomes. In this regard, our results do not aim to be prescriptive; instead, they imply that the intra-individual change in highly experienced musicians can be partly explained by intra-mental processes (inside the person), and to some extent through inter-mental processes (between people), as defined by Vygotsky (1978).

Future studies might explore self-determination within chamber music making to consider simultaneously the types of motivational orientations of groups of musicians, given that we did not explore here the motivations of the different pianists who accompanied the cellist. In addition, according to the statistical analysis, in this study we used the concerts (including all study sessions) instead of per 10 sessions to maximize significance power. Thus, high significance of the data is needed because the regressions in this particular case do not measure the independence of data collection (estimates), so the variability are, in fact, underestimates of the correct variability.

DATA AVAILABILITY STATEMENT

A selection of the datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

This study involves human participants and was reviewed and approved by the Ethics Committee at the University of the Arts Helsinki, Finland. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individuals for the publication of any potentially identifiable images or data derived from this research.

AUTHOR CONTRIBUTIONS

GL-I conceived the presented idea, planned the design of the study, carried out the experiment and artistic project, collected, transcribed, and translated the data, performed the statistical and lexicometrical analyses, and took the lead in writing the manuscript with support from GM in all sections. GM developed the theory in music studies, devised the conceptual ideas of the manuscript, supervised the findings and statistical analysis of this work, contributed to the interpretation and presentation of results, and provided language support, literature advice, and writing encouragement to GL-I. GL-I and GM provided critical feedback, discussed the results, and helped shape the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00385/full#supplementary-material
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