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Musician's Focal Dystonia: A mere neurological disorder? The role of non-organic factors in the onset of Musician's Focal Dystonia: an exploratory Grounded Theory study

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Abstract

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Musician's Focal Dystonia (MFD) is a task-specific, neurological disorder with poorly understood pathophysiology, affecting highly skilled musicians, ending successful careers. Studies found neurological changes in the sufferers' brains, which presumably occurred via negative neuroplasticity, however, surprisingly little is known of what triggers these changes. Recently, non-organic risk factors, such as maladaptive psychological traits and preceding trauma have been suggested by a handful of studies, but the field has not yet been explored in detail. The aim of the study was to identify and describe the non-organic factors which might contribute to the onset of MFD. Due to the study's exploratory nature, a qualitative constructivist Grounded Theory (GT) design was chosen, with the goal of generating a theory that emerges directly from the data. 15 MFD sufferers (5 females, mean age = 36.1) were interviewed for the study. Apart from previously suggested traits, such as anxiety and perfectionism, we found that the educational environment might also be influential. Many participants studied in a negative emotional climate, faced unattainable demands, and were instructed to focus only on the technical aspects of their playing. Consequently, they developed unhealthy practice strategies and negative perfectionism and these problems were often accompanied by negative emotional coping and maladaptive health behaviours. In addition, many participants experienced trauma before the onset of the condition. These findings support the theory that MFD is a multifaceted condition that could partially originate from non-organic factors. It also suggests that the environment – especially the educational approach – might be more influential than previously thought. This might have further implications not only for prevention and research but for the treatment strategies as well. It is likely, that opposing a purely medical procedure, an interdisciplinary approach would enhance the currently used therapies and would increase the possibility of the rehabilitation of the suffering musicians.

1. Introduction

'It has been sincerely miserable on the piano the past several days, yesterday I cried with rage.' (Schumann, Tagebücher, 1971) - wrote Robert Schumann at the young age of 21, when he lost control over the middle finger of his right hand, and soon after, he was forced to quit playing the piano completely. He is the first documented, and posthumously diagnosed case of Musician's Focal Dystonia (Altenmüller, 2006) a debilitating neurological movement disorder, which impairs the fine motor movements of highly

trained musicians (Jabusch & Altenmüller, 2006). The condition is task-specific and painless, typically affecting the hand or the facial muscles, i.e., embouchure but it is possible to have the dystonic symptoms in the shoulders and arms (Jabusch & Altenmüller, 2006) and even the feet (Lee & Altenmüller, 2014). It is estimated that roughly 1% of professional musicians are affected (Jabusch & Altenmüller, 2006), however, this number might be closer to 2%, due to sufferers who might not seek help at all (Ioannou & Altenmüller, 2014). Instrumentalists with higher task requirements and workloads, such as high strings, piano, and guitar seem more vulnerable in general (Altenmüller & Jabusch, 2010), and this risk can increase manifold in specific instrument groups: recently, it has been estimated that up to 27% of brass players might be suffering from the condition (Altenmüller, 2021). Furthermore, the disorder is not widely known and is challenging to diagnose, and the lack of specialised expertise might result in misdiagnosed or undiscovered cases (Rosset-Llobet, Candia, Fabregas i Molas, Rosinés i Cubells, & Pascual-Leone, 2009; Sussman, 2015). The symptoms vary from tremors, spasms, twitching, and tension to extreme weakness in small muscle groups, and result in the loss of control over the affected body part. Most of the subjects are professional classical musicians, who lose their income, artistic outlet, passion, and identity in one tragic and unexpected blow.

While many sufferers experience some improvement in their movement control over time, complete recovery is extremely rare (Altenmüller & Jabusch, 2010), and most often, the condition terminates professional careers. The most frequently used treatment strategy - Botulinum Toxin injections to the affected muscles - is symptomatic, with roughly half of the patients reporting any form of improvement (Jabusch & Altenmüller, 2006; Altenmüller & Jabusch, 2010). Similarly, oral medications, typically Trihexyphenidyl, produce varied results, and many different side effects are reported. More recently, many practitioners are administering behavioural retraining strategies, including constraint-induced retraining, slow practice (Berque, Gray, Harkness, & McFadyen, 2013), and other types of neuromuscular re-education programs (Enke & Poskey, 2018) to a moderate effect. Non-invasive brain stimulation has also mixed results (Cho & Hallett, 2016), and while invasive brain stimulation methods show some promise (Horisawa, Ochiai, Goto, Nakajima, Takeda, Fukui, Hanada, Kawamata, & Taira, 2019), these procedures are both risky and expensive.

Even though the outcome of the different therapeutic approaches is difficult to measure (Spector & Brandfonbrener, 2007; Peterson, Berque, Jabusch, Altenmüller, & Frucht, 2013), it is clear that none of these methods is able to rehabilitate the lost skill completely and reliably. Our inability to construct a standard treatment is partially due to the high variability in the symptoms, however, it is also the direct result of the incomplete understanding of the disorder's pathophysiology. The state of the art is based on traditional dystonia models, which describe the condition as the result of genetically induced maladaptive neuroplasticity (Classen, 2003; Altenmüller & Ioannou, 2016) causing decreased inhibition and increased excitability in different areas of the sufferers' brain (Elbert, Candia, Altenmüller, Rau, Sterr, Rockstroh, Pantev, & Taub, 1998; Byl, McKenzie, & Nagarajan, 2000; Candia, Wienbruch, Elbert, Rockstroh, & Ray 2003; Candia, Rosset-Llobet, Elbert, & Pascual-Leone, 2005; Haslinger, Altenmüller, Castrop, Zimmer, & Dresel, 2010).

However, these frameworks have shortcomings when applied to task-specific variants of dystonia, such as MFD (Sadnicka, Kornysheva, Rothwell, & Edwards, 2018). One of the most distinctive features of MFD is that the symptoms appear exclusively when performing the triggering task, i.e., playing the instrument (Hofmann, Grossbach, Baur, Hermsdörfer, & Altenmüller, 2015), and the patients generally have full control of their fine motor movements in the absence of the instrument. Currently, there is no valid and coherent explanation for this peculiar phenomenon – the general dystonia model cannot explain why all other movements remain unaffected (Sadnicka et al., 2018). To solve this issue, Sadnicka et al. (2018) proposed a new framework that is centred around movement acquisition associated with the task; they originate the involuntary movements from the 'compensatory mechanisms of a healthy motor system' (p 116), rather than seeing it as a dysfunctionality. This new framework draws attention to the nature of the affected movement pattern, particularly its acquisition and practice, identifying several possible risk factors, including physical overuse, inadequate compensatory mechanisms, a discrepancy

between the individual's ability and the task requirements, and accompanying maladaptive cognitive and emotional processes. To this date, there are no comprehensive studies exploring these factors in detail. Only a handful of psychological characteristics have been tested in musicians with MFD and these findings show that musicians with MFD have higher levels of unhealthy perfectionism, anxiety, and phobias compared to healthy samples and musicians with chronic pain (Jabusch, Müller, & Altenmüller 2004; Jabusch & Altenmüller, 2004). Enders et al. (2011) suggest that these traits are not a secondary result of the onset and can be considered as contributing factors. Moreover, preceding traumatic events are frequently mentioned in the literature as triggering factors (Tubiana, 2003), yet, to our knowledge, no in-depth inquiry has been performed to understand the nature of these events, and how they might have influenced the onset.

It seems that in addition to the current medical research exploring changes in the neural levels and genetic predisposition, the sufferers' past experiences including their performance-related behaviours, psychosocial environment, and their psychological characteristics can be an important source of information to clarify the pathophysiology of the condition. Many of these factors are frequently mentioned in the literature, both in a theoretical or an anecdotal way, but apart from the aforementioned psychological characteristics (Jabusch et al., 2004; Jabusch et al., 2004, Enders et al., 2011; Ioannou et al., 2014), very little research has been done to understand them in detail. In addition, there might be other overlooked aspects that contribute to the onset of MFD which were not theorised yet and have further implications for prevention and treatment strategies as well.

Therefore, an investigation with a broader scope is necessary to build a holistic model of the condition. The first step towards this model is to understand the life experience of MFD sufferers and collect and assess the factors which might have contributed to their symptoms: how frequent they are, how they occur in a real-life setting, and how they impact the individual prior to the onset of the disorder. The aim of the present study was to gather data directly from musicians who suffer from the condition in an open and qualitative way. Understanding the common triggers in the sufferers' lives can contribute to not just our theoretical approach, but it could also enhance current therapies, moreover, can help us to establish more effective preventative strategies.

2. Methods and materials

The aim of the present study was to explore the life experience of MFD sufferers prior to, and during the onset, and gain an understanding of the psychological, psychosocial, behavioural, and environmental factors which might have contributed to the development of the condition. In order to explore this relatively uncharted area, a constructivist, qualitative research design, namely Grounded Theory (GT) was chosen. The goal of this flexible, exploratory, and systematic research design is to construct new theories, which are 'grounded' in the data. (Charmaz, 2006., p. 2). By allowing the themes and categories to emerge directly from the raw data, the researcher constructs a theoretical framework that is informed directly by people's experiences and interactions with their environment. In practice, the data collection and analysis happen simultaneously: the immediate analysis of the newly collected data allows ideas and concepts to form, and the evolved concepts point out areas to explore further in the subsequent data collection. The researcher goes back and forth between analysis and data, examining the emerged themes, fine-tuning the next level of data collection, and adjusts the interview schedule accordingly.

2.1 Participants

In alignment with the requirements of GT methodology, a 'selective sampling' was conducted – this means that the participants, who have in-depth knowledge of the topic, are purposefully chosen. The researcher's goal is not to achieve statistical generalisability, but to create, reinforce, and describe the themes which emerge directly from the data (Robson, 2011). Accordingly, 15 participants (5 females,

mean age = 36.1, mean age at the MFD onset = 28.6) were recruited from online support groups (for more details, see Table 1.). The only criterion for taking part in the study was to have a diagnosis of MFD by a medical professional. This was set to ensure that the gathered data is indeed from MFD patients and not sufferers of some different conditions which might produce similar symptoms. Ethical approval was acquired from the Conservatoires United Kingdom Research Ethics Committee and the Arts and Humanities Ethics Committee at the University of York. The participants were informed that the topic might potentially be distressing as they will be asked to talk about their experiences with this disorder and recall events that might be upsetting. They were ensured that they can disclose as much or as little as they wish to and can choose not to answer some questions or withdraw from the study at any time without giving a reason.

2.2 Researcher Reflexivity

The first author is a former sufferer of MFD, who successfully recovered from the condition. Therefore, she approached the research from an 'insider status' (Dwyer & Buckle, 2009) and the participants were made aware of this fact during the recruitment. To maintain reflexivity and avoid bias, the data collection and analysis were closely supervised by the research team.

2.3 Data Collection and Data Analysis

Each interview lasted for 60-90 minutes and was followed by the immediate analysis of the interview transcript employing the prescribed methods of GT. These include four levels of coding, with changing focus: initial coding (labelling every piece of data), focused coding (selecting relevant material and forming the first concepts), axial coding (refining the categories), and theoretical coding (arranging the themes and categories into a theoretical framework). This immediate analysis informed the continuously evolving interview schedule. The initial interviews were open but targeted the period before and during the onset of the condition, inviting the participants to freely talk about their experiences.

In this sense, they can be viewed as Life-Story Interviews (LSI), focusing on the musicianship, career, and MFD of the participants. LSI is frequently used in psychology to shed light not only on the personality traits but also on the processes by which they evolved, highlighting the most influential environmental and social factors (McAdams, 2001). Based on the analysis of the initial interviews, the recurring themes were arranged into a semi-structured interview schedule, which kept evolving throughout the data collection. Also, additional memos were written by the researcher to record hunches and ideas, and to help formulate the categories and, later the emerging model and theory.

Table 1. Participant demographics

	Instrument	Sex	Genre	Level of study*	Type of MFD	Age	Age at the onset
1.	Piano	M	classical	DMA	left hand	38	17-18
2.	Banjo	M	folk and country	amateur	right hand	40	37
3.	Flute	F	classical	DMA	embouchure	29	28
4.	Flute	F	classical	BA	embouchure	26	25
5.	Drums	M	classical	MA	right hand	62	58
6.	Drums	M	jazz and pop music	amateur	left hand	47	38
7.	Piano	M	classical	MA	left hand	31	30
8.	Oboe	M	classical	MA	right hand	56	26
9.	Horn	F	classical	amateur	embouchure	38	19
10.	Horn	F	classical	MA	embouchure	37	35
11.	Drums	M	classical (drumline)	amateur	left hand	19	18
12.	Guitar	M	classical	MA	right hand	27	24
13.	Horn	F	classical	BA	embouchure	34	23
14.	Guitar	M	jazz	BA	right hand	24	23
15.	Tuba	M	classical	DMA	embouchure	34	29

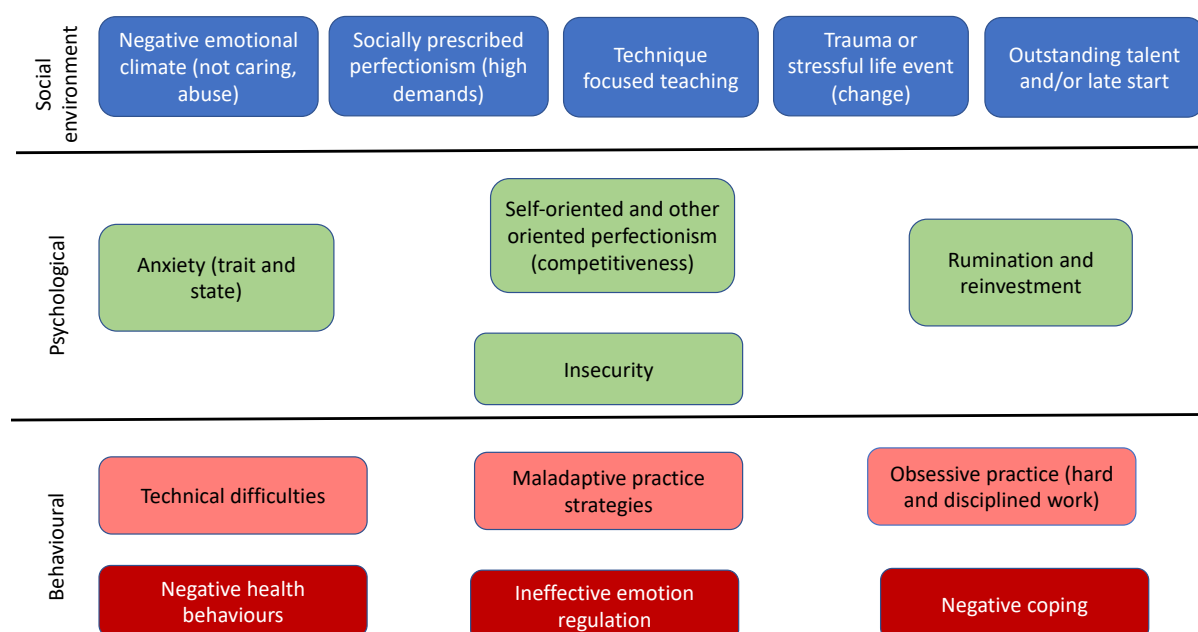
*BA = Bachelor of Music, MA = Master of Music, DMA = Doctor of Musical Arts

3. Results

The analysis of the rich qualitative data highlighted similarities between the life stories of the participants which were marked for further analysis and were added to the interview schedule in alignment with the prescribed methods of GT. The emerging themes were then sorted into three big categories: socio-environmental, psychological, and behavioural factors, with several subthemes in each. For the sake of analysis, these will be presented as separate categories, but they deeply influence each other. A suggestion of the direction of this influence will be made in the discussion, but the scope of the study prevents a deeper examination of the relationship between each element. The resulting model is presented in Figure 1.

3.1 The socio-environmental factors

The themes which were included in this category are all related to the social environment in which the participants grew up, lived, studied their instrument, and worked as a musician. These themes will be discussed in the following order: negative emotional climate, socially prescribed perfectionism, technique-focused teaching, trauma or stressful life event, and outstanding talent and/or late start.

Figure 1. Behavioural–Psychological–Social Environment Model

The first theme in the category was named ‘negative emotional climate’. The participants reported experiencing a very strict, unforgiving, in some cases, even an abusive environment, which was often accompanied by feelings of neglect. These experiences plagued their homes and their workplaces but were experienced most frequently in the educational environment, in which case the perpetrators were most often the instrumental teachers themselves.

‘My first lesson with her, I just walked in, and she would say: sing me an A, which was like...? What? And she was like: no, get out of my office. Don't come back until you improve your pitch. And she would tell us all the time, don't cry, but...but it was hard.’ (P. No. 13)

This was closely related to the next group of themes, ‘socially prescribed perfectionism’. When recalling their youth and music education, the participants reported that highly perfectionist tendencies were prescribed to them, which were often accompanied by feelings of neglect, or emotional abuse.

‘I'll never forget what he told me [...] unless you were the absolute cream of the crop, you're almost worthless.’ (P. No. 5.)

The next theme in the realm of music education was ‘technique focused teaching’: many of the participants reported being taught with no, or little emphasis on musicality or expressivity, and entirely focused on the technical production of the sound.

‘My teacher was very-very technical, very-very methodical, and so for the first semester, he didn't let me play any music at all in our lessons. It was all scales, sound building, and exercises.’ (P. No. 10)

The next theme in the category of psychosocial factors was labelled ‘trauma or stressful life event’. There are mentions of a preceding psychological trauma in the literature (Tubiana, 2003; Altenmüller & Jabusch, 2006), but without an explanation of the nature and influence of these

experiences. This sample provided a wide variety of events that the participants linked to the onset. Some reported psychological trauma, such as the death of a close relative, others talked about major life events which caused elevated stress levels to which the participant struggled to adjust. Often, several of these life-altering changes happened simultaneously:

‘I was graduating with my DMA, organising my wedding, and applying for jobs...it was this huge mess of stress.’ (P. No. 3.)

The last theme in this group was labelled outstanding talent/late start. Interestingly, many participants reported starting their education later than most of their peers, but despite this disadvantage, achieved exceptional feats, and excelled in their education by showing outstanding aptitude.

‘I took the French horn up when I was 15, a little bit of a late starter in French horn. But I immediately excelled. [...] and my teacher was like: you know this is not very common on the French horn to excel this fast. [...] Immediately, I started winning first chair positions in other bands all states, in ensembles and symphonies, I started winning scholarships next year for college, and started winning scholarship competitions where I would end up being a finalist.’ (P. No. 13.)

3.2 Psychological factors

The profile emerging from the data shows individuals who suffer from maladaptive self- and other-oriented perfectionism, anxiety, rumination and low self-esteem.

‘When the mistake happens...it’s automatic anguish...’ (P. No. 10.)

In many cases, participants tried to cope with their psychological distress by continuously supervising and controlling their movements when playing the instrument. This cognitive strategy was dubbed ‘reinvestment’ in the model, following the terminology of sports psychology research.

‘I was pretty self-aware, focused on myself, like observing what I am doing and how am I fitting in, and really not often would I like... enjoy... for example I would very seldom enjoy what others would play.’ (P. No. 2.)

Due to their high self-prescribed standards, insecurity, and low self-esteem, many participants questioned their talents, or their ‘right’ to work in a position they auditioned for and won. These concerns about their ability were so severe in two participants that they even quit playing for a while.

‘I always have thought about myself as a sort of fraud or something.’ (P. No. 14.)

3.3 Behaviours

Given the aforementioned psychosocial and psychological issues the participants had to deal with on a daily basis, it is not surprising that some harmful behaviours have also been identified in the analyses of interviews. These were divided into two main groups: playing-related and non-playing related.

3.3.1 Playing-related

The playing-related behaviours were characterised by obsessive practice and maladaptive practice strategies; apart from the large quantities, many of the participants had maladaptive practice behaviours, most frequently repeating a phrase, or even a full piece, without any strategy. Some participants reported playing up to 8-10 hours every day without any holidays.

‘Well, it’s just the strong will that I have, like unbreakable or something (laughs). [...] It was just harsh work, over and over again [...] It doesn’t matter how much I suffer, I would just do that.’ (P. No. 1.)

Furthermore, many participants reported having technical difficulties which they could not ‘fix’, no matter how much they practised.

‘I would definitely say that I struggled with double tonguing a lot in my life. [...] It has always just been there in the back of my mind, something I’m paranoid about.’ (P. No. 3.)

3.3.2 Non-playing related

The non-playing behaviours were clustered around three main topics: ineffective emotion regulation, negative coping, and harmful health behaviours.

The participants’ lives prior to the onset of the symptoms were typically stressful, due to the previously listed psychosocial and psychological issues, and close to the onset, the early symptoms they were facing. Under this pressure, most of the participants found it challenging to regulate their negative emotions, such as frustration, anger, and despair. The lack of the ability to change or reappraise their circumstances seemed to originate from their rigid perfectionist ideas.

‘Sometimes I would wind up, and I would punch my book on the wire stand, across the room.’ (P. No. 8.)

They also chose negative coping strategies to deal with their situation. The strategies found were most frequently lack of planning, suppression of competing activities, denial, and using substances. The last overlaps with the category of harmful health behaviours.

The theme of substance usage came up later in the interview process and was added to the interview schedule. All the subsequent participants reported alcohol consumption or drug use. Some participants used substances (marihuana or alcohol) to be able to fall asleep.

‘I was smoking a lot of weed that time. I would do it, like, occasionally, yeah, but that year, before the onset, I was doing it every night probably. To fall asleep.’ (P. No. 14.)

Additionally, several others struggled with either insomnia or had very badly scheduled sleep patterns, mostly due to their eagerness to have more time to practice or work.

4. Discussion

The present exploratory study paints the picture of a multidimensional disease with a complex web of possible triggering factors. Genetical predisposition has been shown to play a role (Schmidt, Jabusch, Altenmüller, Hagenah, Bruggemann, Lohmann, Enders, Kramer, Saunders-Pullman, Bressman, Munchau, & Klein, 2009), but our study concludes that the predisposed individuals are impacted by the interplay of psychological, psychosocial, behavioural, and environmental influences leading up to the onset. The individual’s personality traits, music education, personal history, experiences, and behaviours all seem to play a role, and due to the complexity of this system, the origin of the condition resists simple explanations.

Some of these factors emerging from this study were discussed in the literature before, such as anxiety, perfectionism and over-focusing (Enders et al., 2011; Altenmüller, Ioannou, Raab, & Lobniger, 2014). However, listening to the personal recollections of musicians with the disorder identified new areas for further inquiry, moreover, we gained a new understanding of the possible development and trajectory of some of the characteristics.

Even though participants were not directly prompted to talk about their experiences with music education and their early careers (the interviews started with an open invitation to share their stories), all 15 participants included details about their teachers. The data shows that they experienced unfavourable circumstances while learning the instrument, which had a lasting impact on their playing technique, practice strategies, identities as musicians, and cognitions and emotions related to their instrument.

The impact of the instrumental teacher on his/her student in professional music education exceeds the impact of a classroom teacher or college tutor. The teaching is delivered in individual sessions, and the interaction between the student and tutor is intense due to the time spent together (Presland, 2005; Gaunt, 2011), also, the teacher is the primary source of information and support for the student. Instrumental teachers in conservatoires have been described as a musical parent (Creech & Hallam, 2003), and their impact on their students is profound (Patston, 2014). The important role of social relationships in the development of self-oriented perfectionism has already been discussed in family settings (Frost, Lahart, & Rosenblate, 1991), therefore it seems possible that the unreasonably high expectations of the teachers were similarly internalised by the participants. In fact, one of the participants justified and attempted to normalise their maladaptive perfectionist tendencies by quoting their teacher from more than forty years before. As Patston (2014) points out, many teachers unknowingly encourage perfectionism in their students by using a nomenclature that demands a flawless performance instead of focusing on the process of learning.

Maladaptive perfectionism has a detrimental effect on one's mental health. The different psychological challenges reported by the participants have all been explored in the literature in relation to perfectionism. Striving towards unattainable demands and the perceived inability to achieve them results in anxiety (Flett, Madorsky, Hewitt, & Heisel, 2002), which has been identified as an aggravating factor in MFD (Enders et al., 2011). The psychological discomfort is further increased by linking self-worth to achievement (Speirs-Neumeister, 2004), and rumination (Flett et al., 2002) both of which were strongly represented in the sample.

Patston (2014) also points out another possible side-effect of prescribed perfectionism, namely, choosing a too demanding repertoire, or leaving too little time to master the material. Pushing a student over the boundaries of their skillset is even more tempting for a teacher in the case when the student displays outstanding talent, and/or started studying the instrument a few years later than their peers. The data mirrors these ideas: many participants reported very rapid advancement on the instrument (as an example, one participant started playing at the age of 9 and won an international competition at age 11) and/or felt that they had to catch up with their peers due to a late start. This psychological pressure is combined with some neurological disadvantages: the adaptability of the central nervous system is at its highest at a very young age, and individuals who start learning after this window of opportunity has passed, might be more susceptible to MFD (Altenmüller et al., 2014).

Moreover, as Sadnicka et al. point out (2018), discrepancies between the skill and the requirements of the task, either on a biomechanical level or in the neural representation of the skill, are risk factors in developing MFD. In other words, if the available resources are not sufficient to complete the motor task, the attempt can result in overuse and fatigue, or inefficient, compensatory movement patterns. This inefficiently learned technique might be at least partially responsible for the technical difficulties the participants struggled with throughout their careers. In some participants, there has been an attempt to change the established, but inadequate technique, but due to the abrupt and erratic approach, these attempts often achieved the opposite effect, even triggered the symptoms in two cases.

Urging the students to meet challenges prematurely and socially prescribed perfectionism is very unfortunate when it happens unknowingly and in an otherwise positive environment but can be even more detrimental when it is accompanied by bullying, abuse, or harsh criticism, which many of the participants were subjected to. These experiences can have long-lasting effects given that the emotional states and

additional stimuli that are experienced simultaneously with the learning process are influencing the future recall of the skill (Juhan, 2003). We also know that the feedback from the tutor or teacher can lead to immediate changes in the motor behaviour, with positive feedback enhancing the motor performance (Avila, Chiciacowsky, Wulf, & Lewthwaite, 2012), and there might be links between emotions and motor output in different kinds of neurological movement pathologies (Lencer, Steinlechner, Stalberg, Rehling, Orth, Baeumer, Rumpf, Meyer, Klein, Muenchau, & Hagenah, 2009; Ron, 2009). Furthermore, there are links established between Adverse Childhood Experiences and the development of MFD (Alpheis, Altenmüller, & Scholtz, 2021), therefore, it is likely that there might be a similar connection between traumatic events experienced during music education and the onset of the condition.

When a movement is performed repeatedly with a negative connotation, i.e., fear or anxiety of making a mistake or perceived inability to meet the task requirements, it can prompt certain maladaptive cognitive strategies. One of these, which was clearly represented in the sample, was directing the focus to smaller segments of a larger movement in the attempt of gaining better control over it. This conscious interference is described by the Constrained Action Hypothesis (Wulf, 2013), or referred to as 'reinvestment' or 'internal focus' and is identified as harmful to the performance in decades of sports psychology research (Maxwell, Masters, & Poolton, 2006; Wulf, 2013). More recently, the phenomenon has been examined in musical contexts as well, and researchers drew similar conclusions, namely, that internal focus has a negative effect on technical precision and musical expression (Duke, Cash, & Allen, 2011; Mornell & Wulf, 2019). It has also been linked to anxiety and choking under pressure both in athletes (Iwatsuki & Wright, 2016) and musicians (Oudejans, Spitse, Kralt, & Bakker, 2019) and it is closely associated with certain sub-types of the 'yips', the task-specific focal dystonia of athletes (Bennett, Rotherham, Hayes, Olusoga, & Maynard, 2016). Therefore, it is likely that directing the movements with this kind of cognition during practice and performance makes the subject more susceptible to MFD.

The data shows that this kind of cognition was actively encouraged by the teachers of the participants to improve their playing, defining the acceptable performance as the skilful and flawlessly executed motor movements with little or no consideration for expression and musicality. After this approach was established as a way to an immaculate performance, the participants continued to use it throughout their careers to achieve the desired results. This approach exaggerated their anxiety, rumination, low self-esteem, and maladaptive perfectionism which combined with reinvestment, prompted unhealthy and inefficient practice strategies, both in terms of quality and quantity.

There is substantial literature on effective practice or deliberate practice, defining it as a highly structured and planned activity informed by the careful observation of the performance itself and creating specific tasks and strategies to enhance it (Ericsson, Kramp, & Tesch-Römer, 1993). The participants' practice behaviours seemed to lack this kind of structure or clear planning of any sort, and many participants added that they often resorted to unplanned repetition in the absence of any guidance from their instrumental teachers on how to achieve their musical and technical goals, and they often employed this strategy during their careers when they were under increased stress. The lack of planning, which is identified as a negative coping strategy by Carver et al. (1989) was accompanied by over-involvement in the instrumental practice; not taking breaks or holidays and engaging in over-working as an attempt to live up to the external or internal expectations. This behavioural addiction has many documented negative effects on the physical and mental health of musicians (Lawendowski, Bereznowski, Wróbel, Kierzkowski, & Atroszko, 2020), and usually co-exists with suppressing competing activities which also is a form of maladaptive coping (Carver et al., 1989).

Unsurprisingly, in this situation, the participants struggled to regulate their emotions or reappraise their situation. Rumination and catastrophizing were typical cognitive behaviours in the sample which aggravated anxiety. Many reported additional sleep problems in relation to psychological and emotional distress, a topic that has already been linked to overwork in musicians (Lawendowski et al., 2020) and has been raised by researchers in relation to MFD (Akamine, Hirotsu, Andersen, & Tufik,

2015). The relationship between sleep quality and movement control in other movement pathophysiology, such as Tourette syndrome is documented (Cohrs, Rasch, Altmeyer, Kinkelbur, Kostanecka, Rothenberger, Rüter, & Hajak, 2001), but so far, no studies have examined it in the context of MFD.

After a participant reported using marijuana to be able to fall asleep, the topic of substance abuse was added to the interview schedule. The subsequent participants all reported some form of behaviour linked to substance abuse, which was mostly used to mitigate psychological distress or regulate sleep patterns. This maladaptive coping strategy is uncharted in MFD sufferers and can have further implications for movement control.

The findings uncovered many intertwined psychological, psychosocial, and behavioural factors which might have contributed to the onset of MFD in these participants. The current research into MFD primarily focuses on the onset itself and aims to understand the psychological traits and behaviours of the musicians without understanding the trajectory of the development of some of these traits. Our findings show that some of the behaviours, cognitive and emotional patterns contributing to the onset evolved over a longer period of time and at least partially as a response to the external expectations. The collected life stories show that these patterns intensified closer to the onset due to a sudden change or traumatic experience in the individuals' lives. It seems that the onset is the superficial and visible 'product' of a long process of deterioration of mental health and behaviours, rather than just an abrupt disruption of the motor skill. Viewing the participants' lives as complex and evolving systems could help us to clarify the pathophysiology of this complex disorder and can inform preventative strategies.

5. Limitations

Qualitative inquiry, especially when it touches on such a sensitive topic has the innate bias of self-report. Only three of the 15 participants claimed to be fully recovered from the condition, and 12 are still struggling to recover and return to their careers. While research shows that the life satisfaction of MFD sufferers returns to the average level (Lee, Eich, Ioannou, & Altenmüller, 2015) after a sharp decrease following the symptoms, the highly distressing experience of the onset might lead to a distorted view of their history producing a biased narrative. Nevertheless, the participants' thoughts and recollections of the events preceding their onset are a source of valuable information.

6. Conclusion

This study is an important step towards this more holistic understanding of MFD by qualitatively exploring the wide range of possible contributing factors. Certain psychological factors have already been studied, such as perfectionism and anxiety (Jabusch et al., 2004; Jabusch et al., 2004; Enders et al., 2011; Ioannou et al., 2014), but the current study builds on and expands on those findings in two ways. Firstly, using a qualitative methodology and allowing the participants to speak about their experiences, resulted in a richer, more detailed description of the sufferers' personality traits, including their cognitive strategies. Secondly, the findings at least partially explain the development and impact of these traits by collecting data on psychosocial and behavioural factors. In the light of the growing body of research on how the environment and psychosocial factors can influence a wide variety of health and mental health issues (Kiwimaki, Batty, Kawachi, & Steptoe, 2017) it is unwise to ignore these factors in MFD research.

Documenting the personal stories of the sufferers resulted in very rich, qualitative material; however, having a larger sample size would help to crystallize the theoretical model which emerged from this research. Also, it would enhance our understanding of the frequency of these problems in the population of MFD sufferers and would enable us to compare the results with healthy musicians and non-musicians. Therefore, the quantitative inquiry of the elements of the model is suggested for further research.

In conclusion, broadening the field of inquiry and aiming to understand the origins of the condition has further implications for the treatment and preventative strategies. It is possible that including the non-motor symptoms as a therapeutic target, as well as the motor problems, can significantly and positively influence the outcome of the therapy. This idea opens the door to a new, interdisciplinary field at the intersection of music pedagogy, psychology, physiotherapy, and neurology, and has the potential to enhance the current treatment strategies and develop guidelines for preventative strategies.

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