Musician’s Focal Dystonia: A new, holistic perspective

Anna Détári

Doctor of Philosophy
University of York
Department of Music

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Abstract

Musician's Focal Dystonia (MFD) is a task-specific, neurological movement disorder affecting highly skilled musicians which disrupts the fine motor control of the movements necessary for playing an instrument. The understanding of the pathophysiology and aetiology is limited, resulting in the lack of reliable treatment strategies; therefore, full recovery is extremely rare.

The multifactorial origins of the condition are acknowledged, yet the bulk of the research is conducted from a medical perspective, focusing on maladaptive neuroplasticity and the genetic setup of the sufferers. Following the initiative of more recent research which broadened the scope of the investigations, this thesis explores the condition from a holistic perspective, including psychosocial, psychological, and behavioural factors. To reach this goal, a large-scale mixed-method research study was planned with three distinct stages and methodologies which allowed the triangulation of the findings. The first, exploratory Grounded Theory interview study collected the life stories of 15 musicians affected by the disorder to identify potential risk factors. These findings informed the interview schedule of the second qualitative study, which was conducted with 14 practitioners who frequently work with musicians with MFD. This still subjective qualitative data provided information about a large in-direct sample, and insights into the ongoing treatment strategies. The identified risk factors then were tested in a quasi-experimental questionnaire study, comparing musicians with and without MFD.

The triangulated findings indicate the musicians who were later affected by MFD had maladaptive psychological traits and cognitive strategies, exercised negative health and practice behaviours, and experienced traumatic events prior to the onset of the condition. Moreover, it was concluded that many seemingly individual maladaptive characteristics were prompted or aggravated by the social context, especially the educational and work environments. Implications for treatment approaches and preventative strategies and suggestions for further research are discussed in the final chapters of the work.

Declaration and publications:

I declare that this thesis is a presentation of original work, and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as references.

Three of the four studies presented in this thesis were published.

Study 1. (Chapter 4.) is the continuation of my dissertation submitted in partial fulfilment of a degree of Master of Science at the Royal College of Music. The data collection was reopened during my PhD and the results were published:

Détári, A., Clark, T., & Egermann, H. (2022). 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. *International Journal of Music, Health, and Wellbeing*, Spring/Summer 2022. ISSN 2515-981X. Available online: https://www.musichealthandwellbeing.co.uk/ijmhwpublications

A part of the data obtained for Study 2. (Chapter 5.) is available at:

Détári, A., & Egermann, H. (2022). Musician's Focal Dystonia – the practitioner's perspective on psychological, psychosocial, and behavioural risk factors and non-motor symptoms. *Medical Problems of Performing Artists, 37*(3), 200-207. https://doi.org/10.21091/mppa.2022.3023

Study 3. (Chapter 7.) is available at:

Détári, A., & Egermann, H. (2022) Towards a holistic understanding of Musician's Focal Dystonia: Educational factors and mistake rumination contribute to the risk of developing the disorder. *Frontiers in Psychology*, Article 2298. doi:10.3389/fpsyg.2022.882966

Additional publications produced during the completion of the PhD:

Détári, A., Egermann, H., Bjerkeset, O., & Vaag, J. (2020). Psychosocial work environment among musicians and in the general workforce in Norway. *Frontiers in Psychology,* 1315. https://doi.org/10.3389/fpsyg.2020.01315

Détári, A., & Nilssen, T. M. (2022). Exploring the Impact of the Somatic Method 'Timani' on performance quality, performance-related pain and injury, and self-efficacy in music students in Norway: An intervention study. *Frontiers in Psychology*, *13*, 834012. https://doi.org/10.3389/fpsyg.2022.834012

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This thesis was submitted on the 12th anniversary of the onset of my Musician’s Focal Dystonia, and the 8th anniversary of my first solo recital after recovering fully from the disorder. In many religions and mythologies, the number 12 symbolises completion and in this case, I resonate with this sentiment deeply. The trajectory from being a helpless sufferer of an unknown "curse" to submitting a PhD thesis on the topic was a truly exceptional journey and, in a way, it reached a conclusion. I feel grateful for my wonderful family and friends who comforted and encouraged me when I needed it and applauded my successes.

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Part I. Introduction, literature review, and methods

Chapter 1. Introduction

1. 1. The health and well-being of professional musicians

Playing music is one of the most rewarding experiences in life; participating in music-making is shown to enhance wellbeing, social connections, and quality of life (see MacDonald et al., 2012, for a comprehensive review of the literature), so much so that its therapeutic qualities have been exploited throughout human history (Wigram et al., 1995). Engagement with music has been shown to be an effective therapeutic approach to depression (Aalbers et al., 2017), anxiety (Lu et al., 2021), psychosis and other types of serious mental health disorders (Gold et al., 2009), and insomnia (Feng, et al., 2018). The beneficial influence of music has been demonstrated in various settings, such as hospitals (Evans, 2002) and schools (Koopman, 2007); it reduces pain, improves mood, enhances learning, and strengthens communities (MacDonald et al., 2012; Murray & Lamont, 2012).

It would seem logical that professional musicians who are engaging with music-making intensely on a day-to-day basis would reap the most of these benefits of all; however, the investigation of the literature paradoxically shows a reverse, and rather disheartening phenomenon (Bonde et al., 2018; Musgrave, 2022). Mental disorders, such as depression and anxiety are more common among professional musicians than in the general population (Kegelaers et al., 2021; Kenny et al., 2014; Vaag, Bjørngaard & Bjerkeset, 2016). Additionally, performance anxiety, a task-specific and performance-related mental health problem affects a high percentage of this population (Kenny, 2009; Matei & Ginsborg, 2017), in some cases, resulting in the termination of the career (Nagel, 1993). Musicians are also more likely to have social anxiety (Kenny et al., 2014) and insomnia (Vaag, Saksvik-

Lehouillier, Bjørngaard et al., 2016) than the general workforce, possibly due to the higher levels of psychological distress.

Physical problems are also prevalent in this population (Cruder et al., 2020; Kok et al., 2016; Zaza, 1998): an alarmingly high percentage of musicians suffer from Performance-Related Musculoskeletal Disorders (PMDRs) and other types of performance-related injuries and pains. These physical problems are already rampant from the beginning of the professional studies with up to 67% of college-level students experiencing performance-related pain (Cruder et al., 2020; Stanek et al., 2017), and similar numbers are observed in professional environments, such as orchestras (Ackermann et al., 2012; Berque, et al., 2016; Leaver et al., 2011).

Other performance-related problems are neurological in nature. Among these, nerve entrapment issues, such as tendonitis and ulnar neuropathy at the elbow are originated from a localised area in the extremities and can be corrected with surgical and non-surgical interventions, such as physiotherapy and modification of the instrumental technique (Wilson et al., 2014). Musician's Focal Dystonia (MFD), however, originates in the central nervous system (Altenmüller & Jabusch, 2009; Byl et al., 1996; Sadnicka et al., 2018; Sadnicka et al., 2021; Sussman, 2015) and is probably the most peculiar and elusive movement disorder among performance-related issues; its symptoms are task-specific, only manifesting when the triggering task is performed (Hofmann et al., 2015) and the understanding of the pathophysiology and aetiology is limited (Altenmüller & Jabusch, 2009; Conti et al., 2008, Jankovic & Ashoori, 2008). Affecting about 1% of the musician population (Altenmüller, 2003), its symptoms sabotage many promising careers (Richardson et al., 2017; Schuele & Ledermann, 2004) and there are no reliable treatment strategies (Altenmüller & Jabusch, 2009).

There is an increasing awareness of the prevalence and seriousness of performance-related issues among musicians in the last decades which resulted in the establishment and development of Performing Arts Medicine (PAM) and music performance psychology (Brandfonbrener, 1991; Chong et al., 1989, Harman, 1993; Steptoe, 1989). These relatively young fields focus on the physical and mental health of performing artists and undertook excessive research to unearth the potential risk factors of this epidemic of disorders in musicians in the past decades. The findings show that the physical demands of playing an instrument (e.g., the repetitive nature of the movements, asymmetrical postures, non-ergonomic instruments), the long working hours, and the constant exposure to evaluation by peers, superiors, and the audience itself is at least partially responsible for the observed physical and mental health difficulties (Cruder et al., 2020; Jacukowicz, 2016; Kok et al., 2016). The biomechanical qualities of the movement patterns used to play the instrument also gained a lot of interest recently (Baadjou, 2018; Baadjou et al., 2017; Visentin et al., 2008) including the general playing posture (Shoebridge et al., 2017; Steinmetz et al., 2010) and it has been suggested that inefficient technique combined with a maladaptive posture can increase the risk of developing occupational problems (Chan & Ackermann, 2014; Détári & Nilssen, 2022; Steinmetz et al., 2010; Visentin et al., 2008). Furthermore, it is likely that the received music education plays an important role in the acquisition of the incorrect playing mechanisms, which has further implications for the rest of the musicians' careers (Détári & Nilssen, 2022; Waters, 2019; Waters, 2020a; Waters, 2020b).

Researchers also considered the role of psychological and psychosocial factors in developing occupational injuries. Due to the high demands of the profession, over-involvement with musical tasks is often observed which interferes with other areas of the individual's life, such as social connections and work-life balance, leaving the musician in a psychologically vulnerable state (Lawendowski et al., 2020). Furthermore, it is likely that musicians develop their health-related beliefs and attitudes towards pain and injury in the educational and professional setting (Norton, 2016; Waters, 2020b), and these beliefs play a significant role in acquiring occupational problems and are also hindering the musicians from receiving appropriate support (Ackermann, 2017; Rickert et al., 2014a; Rickert et al., 2014b). The psychosocial attributes of the learning and working spaces, such as the demands placed on the individual and the support they receive are also in a direct relationship with the musicians' physical and mental wellbeing (see Jacukowicz, 2016, for a summary of the literature). Unfortunately, research into this topic shows that musicians have much less favourable psychosocial work and learning environments. Perkins et al. (2017) identified several barriers to optimal health in conservatoire students on an institutional, lifestyle, and support system level, and Détári et al. (2020) found that professional musicians of all genres receive less support, feel less rewarded both in terms of salary and acknowledgement, and have more life-work conflicts than the general workforce. Various studies linked these stress-inducing psychosocial factors to performance-related injuries in various settings, such as symphony orchestras (Hasson et al., 2009; Holst et al., 2011), high schools, and conservatoires (Akel & Duger, 2007).

In summary, occupational musculoskeletal and mental health problems were investigated in a multidisciplinary manner, approaching the problem from a broad, holistic viewpoint, contextualising the issues and accounting for the various influences stemming from the psychosocial environment. Musician's Focal Dystonia, on the other hand, due to its neurological origins, has been nearly exclusively researched from a narrow, medical perspective in the past decades, examining the genetic predisposition of the affected musicians (Lohmann et al., 2014; Schmidt et al., 2009; Schmidt et al., 2011) and the maladaptive neurological changes which take place (Byl et al., 1996; Byl et al., 2000; Candia et al., 2003, Candia et al., 2005; Elbert et al., 1998; Haslinger et al., 2010). While this narrow focus furthered our understanding of the heredity factors and the neurological changes which take place in the musicians' brains, the aetiology is still unclear (Altenmüller & Jabusch, 2009), which makes the treatment and the development of preventative strategies challenging.

More recently, researchers broadened the field of inquiry and explored the psychological characteristics of musicians with the disorder. A string of studies showed that musicians with MFD have higher levels of anxiety, perfectionism, and social and other types of phobias than healthy musicians and musicians with chronic pain (Enders et al., 2011; Jabusch & Altenmüller; 2004; Jabusch et al., 2004), and it has been concluded that these are pre-existing characteristics rather than psychoreactive traits responding to the onset (Altenmüller & Jabusch, 2009; Enders et al., 2011). However, compared to the depth and breadth of the literature on other performance-related issues in musicians, research into MFD still lacks a holistic approach and neglects various potential contributing factors and this stance potentially hinders the development of more effective treatment and preventative strategies.

The bulk of the literature overlooks the context in which the learning and performance of the affected skill took place and the individual's relationship to this environment. Moreover, *what* was being learned and practised, i.e., the biomechanical quality of the instrumental technique before the onset, and the performance- and health-related behaviours of musicians with MFD are under-researched. The role of the most important social actors in developing the instrumental technique and related behaviours is also not elucidated. To summarise, the developmental trajectory of the affected musicians in terms of psychological traits, belief systems, performance-related behaviours, and the affected skillset itself is an uncharted area, even though it might have a significant role in the development of the condition.

Therefore, this thesis aims to investigate MFD from a more holistic perspective, accounting for psychosocial, psychological, and behavioural factors which might influence the development of the condition. Based on Engel's (1977) biopsychosocial model and exploiting Ahn et al.'s (2006a) "systems thinking", it also aims to understand how these factors influence and aggravate each other and inform the complex relationship between the musician, their instrument, their learning and career, and their environment. Opposing past research where the majority of the hypotheses were formulated based on previous literature, medical concepts, or observations, this thesis approaches this complex problem in an exploratory and pragmatic way, laying the foundations of the hypotheses on the personal narratives of musicians with the disorder, and structuring and generalising the subsequent findings on this basis.

The threefold goal of this research is:

1. To develop a more holistic model of MFD
2. Based on this model, propose ways to enhance the existing treatment approaches
3. Make recommendations for preventative strategies.

To reach this goal, the following research questions were formulated to guide the research:

1. What were the characteristics of musicians' personal and professional live prior to the onset of MFD?
2. How did these factors potentially influence the development of the symptoms of the disorder?
3. How might these factors influence the rehabilitation from the condition?

4. Based on the acquired information, what steps could be taken to protect the next generation of musicians from the disorder?

1. 2. Overview of the thesis

The rationale for the thesis was introduced at the beginning of this chapter. Part I. includes the background, literature review, the rationale for this research, and the methodologies used. More specifically, Chapter 2. starts with a detailed overview of the phenotypes[1], most typical symptoms, and prevalence of MFD. Following this, the history of the research, the classification, and the current models are explored in three subsections. Section 2.2.2. introduces the neurological model and its development and presents the medical theories about the pathophysiology and aetiology of MFD. Section 2.2.3. discusses the rationale for the expansion of this approach into a neuropsychiatric model and the historical and current understanding of the role of psychological factors in the onset of the disorder. Additionally, the most recent initiatives to include psychological and cognitive factors into the pathophysiology are introduced. Section 2.2.4. broadens these models further and proposes a holistic model built on a biopsychosocial framework. This is followed by a discussion in section 2.3. about how these theories inform the currently used treatment strategies with a detailed description of the available therapeutic approaches. The theoretical framework of the research, its epistemology, its methodology, and the overview of the conducted studies are discussed in Chapter 3., including a subsection about researcher reflexivity and the ethical considerations taken during the data collection.

Part II. of the thesis introduces the empirical studies conducted for this research in four chapters (4-7). Part III. consists of three chapters, corresponding to the three main goals of the research identified above in Section 1.1.: in Chapter 8., an overarching holistic model

[1] Phenotype is a set of observable characteristics or traits of a phenomenon.

of the condition is presented based on the triangulated findings; Chapter 9. is a discussion about complementing treatment approaches based on the findings, followed by recommendations for preventative strategies in Chapter 10. The thesis is concluded with Chapter 11., summarising the main findings, and making suggestions for further research.

Chapter 2. Literature review

2. 1. Musician's Focal Dystonia - The state of the art

Musician's Focal Dystonia (MFD) is a painless, task-specific neurological movement disorder, which impairs the fine motor movements of accomplished musicians when playing the instrument (Jabusch & Altenmüller, 2006; Conti et al., 2008; Sussman, 2015). Most often, the resulting loss of control makes it impossible for the musicians to continue their careers in the same manner, which leads to psychological distress and, for some, financial insecurity. The aetiology and pathophysiology of MFD are not well understood (Altenmüller & Jabusch, 2009), the disease progression is not fully explained (Stein et al., 2016), and while the current treatment strategies can improve movement control (Enke & Poskey, 2018; Jabusch et al., 2005; Van Vugt et al., 2014) none of them is predictably effective (Sadnicka et al., 2018) and complete recovery is extremely rare (Jabusch & Altenmüller, 2006).

The symptoms are disordered movement patterns, which can be described as repeatedly recurring or sustained spams, tremors, or tension, resulting in involuntary movements (Conti et al., 2008; Sussman, 2015). The exact pattern of the impaired movements is highly dependent on the location and the instrument played (Altenmüller & Jabusch, 2009), but the co-contraction of agonist and antagonist muscles is often observed (Tubiana, 2003; Wilson et al., 1993), which can subsequently influence neighbouring muscles as well (Sussman, 2015). While excessive tension is considered the most typical issue in the affected body part, in some cases, the problem might stem from hypoactivation and reduced responsiveness and flexibility in some areas (Chopyk, 2021; Iltis et al., 2016). Additionally, while attempting to meet the task demands, the affected musician might develop compensatory movements[2] which further the complexity of the compromised motor pattern.

One peculiar characteristic of the condition is its highly task-specific nature (Hofmann et al., 2015), in other words, the symptoms only manifest themselves when the musician attempts to play their instrument. For some affected individuals, this task-specific nature is even more extreme; it has been observed that some musicians only experience the symptoms when playing in a specific range, using a distinct technique, or when they modify the speed or direction of the playing (Frucht, 2016; Jankovic & Ashoori, 2008; Sadnicka et al., 2016; Tubiana, 2003). On the other hand, in a proportion of the cases, the symptoms can spread to similar activities (Rosset-Llobet et al., 2007), for example, a pianist with hand dystonia might experience problems with typing or an embouchure dystonia sufferer might develop issues with eating or speaking (Frucht, 2016; Jabusch & Altenmüller, 2006).

Those who experience MFD are most often classical musicians, with much fewer occurrences among performers of other genres, such as jazz, pop, and rock music. The most feasible explanation of the vulnerability of the classically trained musicians is the restrictive nature of the genre itself: nearly all aspects of the performance are prescribed, leaving relatively little room for variations in the movement behaviour (Altenmüller & Jabusch, 2010; Sadnicka et al., 2016). In classical music, the tempo, the rhythm, the notes themselves, and even the dynamics and the expressive elements are set in the notated music. Furthermore, in orchestras and ensembles, the musicians are required to express the conductor's musical ideas, produce a uniform sound, and sometimes they are constricted in the movement patterns used, e.g., the pre-organised direction of the bowing of string instrumentalists playing in unison. In addition, social constraints and the expectations of the audience place an additional

[2] When a normal movement pattern becomes unavailable, other movements are used to complete the motor task, employing additional muscles (which might not be ideally placed or suited for the task) or using already involved muscles differently.

burden on the musician (Altenmüller & Jabusch, 2009). This means that the movements need to be performed with extreme precision repeatedly, and the margin for error is minuscule. From a neuroscientific viewpoint, such movement behaviour leads to a highly specialised, optimised, and stereotyped neuro-network, with decreased flexibility and transferability to other tasks which makes it vulnerable to impairments (Sadnicka et al., 2016).

Apart from its restrictive quality, other characteristics of the played material also appear to be greatly influential, such as its complexity and virtuosity. Instrumentalists who are expected to play a more technically demanding repertoire - such as high strings, high brass, woodwind, piano, and guitar - are more vulnerable to developing the condition (Altenmüller & Jabusch, 2010). Workload as a risk factor can also be observed in asymmetrical instruments: the hand with more complex tasks to perform is affected much more often, such as a left hand versus the right hand of a violinist, probably due to the increased demands on sensorimotor[3] precision (Altenmüller & Jabusch, 2010; Sadnicka & Rosset-Llobet, 2019). When MFD affects one of the hands, handedness also seems to play a part: the dominant hand is more often affected (Baur et al., 2011; Schmidt et al., 2013).

MFD can impair the control of any body part which takes part in the sound production (Ray & Pal, 2022), but there are some phenotypes that appear to be more frequent than others (Lim & Altenmüller, 2006). The most frequently described and well-documented type is MFD of the fingers and hands, so much so that the term “Musician’s Focal Dystonia” is sometimes used interchangeably with this subtype. The first posthumously diagnosed case of Focal Hand Dystonia is Robert Schumann (Altenmüller, 2006); more recent examples include several renowned pianists, such as Glenn Gould (Wilson, 2000), Gary Graffman (Jankovic & Ashoori, 2008), and Leon Fleischer (Chang & Frucht, 2013). As the latter two pianists’ stories appeared in the media in the 1980s, researchers took a renewed interest in the

[3] Nerves (or their output) involved in both motor and sensory functions.

condition, which led to decades of excessive research into the hand problems of classical musicians. Most often, the condition is observed in pianists' and guitarists' hands, but it appears to be frequent in strings, woodwind players (Jabusch et al., 2005), and percussionists as well (Lederman, 2004). One prominent and highly publicised case from recent years is Alex Klein, who left his position as a principal oboe player at the Chicago Symphony Orchestra due to MFD in his hand (Klein, 2016; Toner et al., 2016). The most typical symptoms are curling or overextending fingers, and lack of precision in scales, trills, and forked fingerings[4] (Altenmüller & Jabusch, 2010).

Embouchure[5] dystonia (ED), a subtype of MFD, was overlooked and understudied for decades, with the first comprehensive report - describing 26 cases - published as late as 2001 (Frucht et al., 2001). One reason for this might be that in wind players, a large portion of the anatomical systems contributing to sound production is inside the body; therefore, the symptoms might be less visible and observable (Chopyk, 2021). Apart from the facial muscles and the jaw, ED can affect the tongue and the throat as well, disrupting the control of the airstream as it is directed into the instrument (Iltis et al., 2015; Iltis et al., 2016; Termsarasab & Frucht, 2016). Brass players seem particularly susceptible: some estimations suggest that up the 27% of professional brass players are affected (Altenmüller, 2021). Frucht (2016) produced a video guide for diagnosis and evaluation and identified several distinct phenotypes of ED: tremor, lip-pulling (part of the lip is involuntarily moved away from the centre of the embouchure), lip-lock (part of the lip is fixed in one position), and symptoms affecting the jaw and the tongue. These tension-based patterns might be the subsequent reaction to a less efficient movement strategy within the oral cavity; Iltis et al. (2015; 2016) found that dystonic horn players are employing less movement when adjusting the size of the

[4] Forked fingering refers to a hand position pattern on an instrument when lifted and closed positions are altering in the neighbouring fingers.
[5] Embouchure is a term describing the collection of the anatomical structures which contribute to the sound production on a wind instrument.

oral cavity compared to unaffected horn players and suggested that the resulting slower airstream puts an excessive amount of tension on other parts of the embouchure. These motor disruptions can lead to the loss of certain registers or specific techniques, such as tonguing, unreliable sound production or change of pitch, or, in the most severe cases, the complete loss of the ability to create a sound (Chopyk, 2021; Frucht et al., 2001; Iltis et al., 2016).

Other types, such as lower limb dystonia are still treated as peculiarities in the literature, and very little is known of the prevalence, with only a handful of articles published on the topic (Lee & Altenmüller, 2014; Rosset-Llobet et al., 2012). These articles describe drummers suffering from involuntary movements in the lower extremities when using the pedal of the drum set. Interestingly, this particular phenotype is possibly the only one where the majority of the affected musicians are not classical musicians: the patients in these studies were jazz, hard rock, and heavy metal performers (Lee & Altenmüller, 2014; Rosset-Llobet et al., 2012). This can be explained by the levels of precision, intensity, and prolonged repetition required from a drummer in these genres; in many ways, it is similar to the restrictive and prescribed nature of classical music.

Another specific sub-type of MFD is the dystonia of the vocal cords in signers, also known as laryngeal dystonia or spasmodic dysphonia (Chitkara et al., 2006; Ray & Pal, 2022). The classification of laryngeal dystonia or singer's dystonia as MFD, however, is not a well-established fact. Laryngeal dystonia is also a speech disorder affecting the general population, causing voice breaks, hoarse sound quality, and effort while speaking due to involuntary muscle contractions in the laryngeal muscles (Ludlow al., 2008). While Halstead et al. (2014) state that singer's dystonia is markedly different from the speech disorder under the same name, their sample of four cases and the retrospective methods used, call for more data. Similarly, the five case studies presented by Chitkara et al. (2006) do not show clear signs of the task-specific nature, which is an important marker of MFD; the problems are not specifically linked to using the voice to make music, and they also affect the speech to a certain extent. This opens the question of whether this is a non-task-specific disorder impacting singing voice, or a task-specific one, originating from the prolonged practice of singing. Due to this uncertainty, and the limited data, singer's dystonia was excluded from this research.

Classifying the subtypes based on the affected body part is a logical organisational system but it is not very informative in terms of the severity of the movement impairment. To solve this issue, Altenmüller et al. (2014) proposed a new system. While analysing different types of motor failures in musicians, five different categories emerged: Motor Fatigue (MF), Overuse Syndrome (OS), Chocking Under Pressure (CUP), the Dynamic Stereotype (DS), and Focal Dystonia in Musicians (MFD). Arguably, the first two categories have a strong physical component; therefore, they are not considered neurological disorders. CUP is a term borrowed from sports psychology, where it is frequently used to describe events when there is a perceived mismatch between the individual's skills and the motor task's requirements (Mesagno & Beckmann, 2017). This subjective interpretation of the situation leads to anxiety and fear of failure, and as a result of these cognitive processes, impaired movement control (Iwatsuki & Wright, 2016). CUP is considered to be a psychological problem and the developed interventions (creating pre-performance routines, cognitive strategies, visual fixation, and acclimatization before the performance) (Mesagno & Backmann, 2017) align with this classification. In musicians, a similar phenomenon labelled Musician's Performance Anxiety (MPA) is more thoroughly researched (see Kenny, 2011, for a comprehensive review); however, it is important to point out that MPA does not necessarily lead to motor problems during the performance and can be a purely psychological experience (Kenny, 2009; Kenny, 2011). From the point of interest of this thesis, the intriguing part of this classification is the distinction between DS and MFD.

This framework can be understood as an axis from physical, through psychological, to neurological disorders, the last two categories fall in the neurological end and produce similar symptoms. According to the authors, the main difference between DS and MFD is that DS seem to be “more modifiable and fluctuating” (Altenmüller et al., 2104, p. 94.), while MFD is resistant to behavioural therapies and is not modifiable by sensory tricks. Moreover, MFD seems less task-specific and has the tendency to spread to other, similar tasks, and even manifest itself as a permanent, non-task-specific dystonia in some cases. While this classification explains how some musicians can achieve full recovery from the disorder, the striking similarities between DS and MFD suggest that they are, in fact, the same disorder on different points of the severity axis. The authors acknowledge major overlaps between DS and MFD (Altenmüller et al., 2014), and due to this grey area between the two, they might not form distinct categories. In a world, where there is a struggle with the MFD diagnosis altogether (Rosset-Llobet et al., 2009), this subtle difference possibly escapes most neurologists and researchers; when describing the participants in research studies, authors generally do not differentiate between DS and MFD. Also, the classification was proposed only a few years ago and was not adopted by many researchers; therefore, for the sake of consistency, the term MFD will be used in this thesis, unless it is prompted otherwise by the used literature.

It is estimated that 1% of accomplished musicians are affected by MFD (Altenmüller, 2003), but due to several factors, this percentage might be underestimated (Richardson et al., 2017). Some musicians might not seek help at all due to feelings of shame, fear of losing their jobs (Conti et al., 2008), or they simply fail to recognise that they have a medical condition rather than a technical issue on the instrument. Additionally, not all of those who seek medical help receive a correct diagnosis. MFD affects only a small portion of the general population; therefore, it is not widely recognised, and without specialised expertise misdiagnoses often occur (Rosset-Llobet et al., 2009; Sussman, 2015).

The onset typically occurs after many years of rigorous practice, most often in the prime of the musician's career, usually in the fourth decade (Chang & Frucht, 2013; Conti et al., 2008; Jankovic & Ashoori, 2008). There are certain hypotheses to explain this phenomenon: it is possible that the triggers accumulate over time and the appearance of the symptoms is just the endpoint of a longer, undetected deterioration, or the age-related decline forces the motor system to develop compensatory strategies which turn maladaptive (Sadnicka et al., 2016). While the mid-30s is the most typical age for the onset, the reported age range in many studies is much broader, for example, in Jabusch & Altenmüller's (2006) study, the participants' age was spanning from age 16 to 63.

The data from current studies show that there is an overwhelming percentage of male musicians with MFD, placing the ratio between 1:2 and 1:6 (Lim & Altenmüller, 2006). Similar ratios have been consistently reported in the past decades; however, without any distinction made between sex assigned at birth and gender: a limitation which results in the complete lack of information about MFD in trans and non-binary populations. Due to this limitation in the literature, the conclusions drawn can only be based on the binary (male and female sex assigned at birth) differentiation between sexes.

Most researchers attribute the significant difference between male and female groups among the affected musicians to genetic predisposition (Altenmüller & Jabusch, 2009) but there are other social factors which might contribute to these skewed numbers. The general bias favouring men in the profession might be one of these reasons: music conservatoires and symphonic orchestras, which are the main forms of study and employment for Western classical musicians, are traditionally male organisations (Allmendinger & Hackman, 1995). While the demand for social equality and the introduction of blind auditions increased the number of female musicians in orchestras, discrimination is still an ongoing problem (Phelps, 2010) and in general, men players still significantly outnumber female players (Sergeant & Himonides, 2019).

To adjust for this possible bias, Lim & Altenmüller (2006) used the proportions of male and female musicians studying in eight different conservatoires and compared it to their sample of musicians with MFD. They found that the difference between sexes in terms of acquiring dystonia cannot be explained by the higher number of male musicians studying in higher education and concluded that males are more susceptible to developing the condition. However, the methodological decision to choose younger instrumentalists as a control group in order to represent all instrument groups (Lim & Altenmüller, 2006) poses the question of whether the studied and control groups can be treated as homogenous. Uprooting gender inequality is still an ongoing process, frequently hindered by elitist and gender-biased views (Allmendinger & Hackman, 1995; Phelps, 2010); as an example, the Vienna Philharmonic hired its first female member as late as 1993 and still had only six female members in 2003 (Roberts, 2018). Therefore, the generational difference between groups might mean that the students in the control group participated in a significantly different culture in terms of gender equality.

The correlations between sex and preferred instruments also might play a part in this equation (Brandfonbrener, 1995; Lim & Altenmüller, 2006). It is clear that certain instrument groups are more susceptible to developing MFD (Altenmüller & Jabusch, 2010; Lim & Altenmüller, 2006) and at the same time, some instruments are more likely to be played by females, such as flute, while others are preferred by males, such as brass instruments (Hallam et al., 2008). The selection of the instrument is often influenced by gender stereotyping

(Walker, 2004) such as perceiving females as weak to carry larger instruments or to play ones which need a strong airflow, such as a trombone or tuba (Phelps, 2010). Women playing such instruments might be actively discouraged from doing so, might have problems with employment and furthering their careers, and are more likely to suffer from harassment in the workplace when employed (Phelps, 2010). As a result, some instruments which are highly susceptible to MFD, such as brass instruments (Altenmüller, 2021), are played by much fewer women professionally in general (Lim & Altenmüller, 2006; Sergeant & Himonides, 2019) which might contribute to the gender differences in MFD.

Moreover, the participants in the majority of the published literature are recruited from the pool of patients involved with the researchers' neurological or other types of medical practice; this participant selection includes exclusively those who come forward, get diagnosed, and receive some form of treatment. The gender bias in medical diagnosis and treatment, i.e., women are more likely to be dismissed when complaining about their symptoms and are treated differently is frequently reported (Alcalde-Rubio et al., 2020; Hoffmann & Tarzian 2001; Perez, 2019; Samulowitz et al., 2018). While there are no studies examining this in the context of unexplained movement disorders, it seems likely that a condition with such a subtle and task-specific symptom and without any apparent physical cause might be subject to more frequent dismissal in some female sufferers. Therefore, it would be important to explore the question of gender distribution further because it has implications for the ongoing genetic studies, not to mention the diagnosis and treatment of female musicians.

In summary, MFD is a highly debilitating disorder affecting performing musicians, often terminating professional careers. Among all other types of task-specific focal dystonias, musicians are the most vulnerable to suffering from the condition (Altenmüller & Jabusch, 2009). While the research in the past decades significantly improved our understanding of MFD, the disease progression is not fully explained, and the treatment strategies are not able to reliably rehabilitate the playing skill (Sadnicka et al., 2016); therefore, the state of the art is continuously evolving. The theories and models of the condition underwent a series of significant changes since the first medical descriptions in the 19th century, often contorted by contemporary views (Garcia-Ruiz, 2013), some of which are still influencing the current understanding. To provide a clear picture of this influence, the following sections discuss the current consensus on the pathophysiology, psychopathology, and aetiology of MFD from a historical perspective.

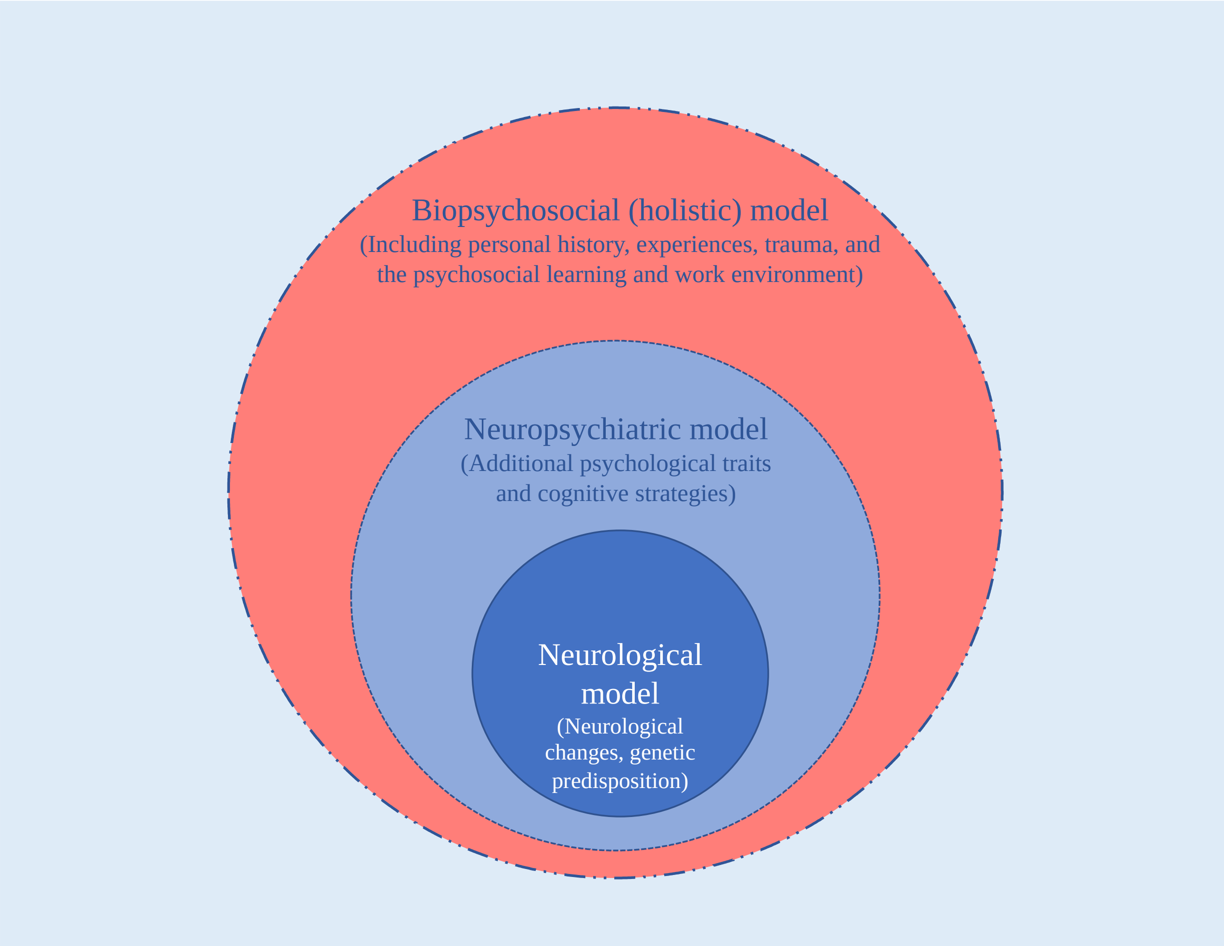
2. 2. The three-layered model of MFD

Currently, MFD is primarily examined from a strict, neurological perspective, and suggestions for further research align with this medical approach (Richardson et al., 2017). However, recent initiatives began to broaden this understanding and suggested including psychological and cognitive factors in the aetiology as well (Altenmüller & Jabusch, 2009; Altenmüller et al., 2014) and the goal of this thesis is to further this process by involving additional behavioural and psychosocial factors and consider the condition from a holistic, biopsychosocial perspective. In a sense, this can be imagined as a multi-layered model in which each layer is underpinned by different theoretical frameworks and in a broader sense, epistemologies.

Each layer in this model (neurological, neuropsychiatric, and holistic) is presented one by one in the following sections and examined from a historical perspective in order to better understand their development in the contexts of contemporary influences. Their shortcomings and limitations will also be discussed providing a rationale for the present research. It is important to note that this somewhat artificial structure does not give rise to the exclusion of neurological findings and neuroscientific understanding of the past decades. These remain at the core of the model while complemented by additional risk factors, as it is demonstrated in Figure 2.1. The broader, biopsychosocial examination of the life stories of musicians with the condition, accounting for external and internal influences, is aimed to identify the triggering factors which further the maladaptive neuroplasticity identified by neuroscience research.

Figure 2.1.

The three-layered model



2. 2. 1. Classification, pathophysiology, and the neurological model

The classification and the suggested pathophysiology of MFD have been through significant changes in the past century, which has had a profound impact on how the condition is viewed, researched, and treated today (Albanese, 2017; Garcia-Ruiz, 2013; Munts & Koehler, 2010). According to the most recent consensus, MFD is a subtype of dystonia, which is defined in the following way:

> Dystonia is a movement disorder characterized by sustained or intermittent muscle contractions causing abnormal, often repetitive, movements, postures, or both. Dystonic movements are typically patterned, twisting, and may be tremulous. Dystonia is often initiated or worsened by voluntary action and associated with overflow muscle activation. (Albanese et al., 2013, p. 866)

Dystonia is an umbrella term, which was first coined by Oppenheim in 1911 to describe torsion spasms (Albanese, 2017), currently covering many different types of movement disorders that vary greatly in terms of the location, severity, and the nature of the symptoms. To differentiate between them, further subcategories were proposed on two axes: clinical features and aetiology (Albanese et al., 2013). While this system seems a comprehensive and methodical approach for providing clinicians with meaningful information about the characteristics of the subtypes of the disorder, Sadnicka et al. (2016) critiqued it for not capturing the unique features of the task-specific variants.

Historically speaking, these task-specific variants were viewed as distinct disease entities, classified as “occupational neuroses” or “trader’s palsies” in the late 19th century, and as the name suggests, were directly linked to various professions and the specific movement patterns they required (Garcia-Ruiz, 2013). Examples include money counters, milkers, masons, and watchmakers, and the disordered movements are described in detail in the first comprehensive neurology treatises: Hammond's *A treatise on the diseases of the nervous system* (1876), and Gower's *Manual of diseases of the nervous system* (1886). In Gower's text (1886), there are also specific mentions of musicians affected by this disorder, namely violinists, harpists, and zither players.

The patient group suffering from these task-specific movement disorders is in continuous flux in response to industrialisation and technological advances: as certain professions disappeared, so did the disorders associated with them, and new inventions led to new subtypes of the condition. As an interesting example, the introduction of the Morse code in the early 20th century led to a huge increase in telegraphists' cramp as it required rapidly repeated sequences of extremely precise movements (Sadnicka et al., 2016). More recently, new disorders seem to form around repetitive movements associated with the 21st-century lifestyle, such as finger dystonia when using a computer mouse (Linssen et al., 2013; Suzuki et al., 2012).

The differentiation between task-specific and non-task-specific movement disorders started to get dismissed by theories regarding genetic links between different subtypes of dystonia (Zeman et al., 1959). The observation of patients with both types of the disorder, and family members displaying different versions of these movement deteriorations led to the conclusion that there must be a heredity element involved. While some neurologists still argued that these disease entities should be classified separately, and the symptoms, however similar they might be, might have different origins (Fahn & Eldridge, 1976), the classification system which grouped together the various symptomatologies became widely accepted. The leading voice in this debate was Marsden, who proposed that blepharospasm[6], facial dystonia,

[6] A condition affecting the eyelids, causing uncontrolled blinking.

writer's cramp, torticollis (cervical dystonia), truncal, and leg dystonia are the manifestations of a single illness syndrome, all related to idiopathic[7] torsion dystonia (Marsden, 1976; Albanese, 2017). While Marsden did not specifically include Musician's Focal Dystonia in their articles, they classified other types of task-specific movement disorders under the same umbrella term, creating one group with all dystonias together (Albanese, 2017). While there is an ongoing debate on whether this classification should be viewed as a single disease, a collection of typical symptoms, or a syndrome (Albanese, 2017; Garcia-Ruiz, 2013), it led to the conclusion that the origin and pathophysiology of these widely different disorders must also be similar. This assumption set the path for future research and treatment strategies, which had a huge impact on how MFD is currently viewed and determines how the individual musician is treated in medical practices to this day.

Therefore, in order to understand the origin of the current hypotheses and research trajectory concerning the pathophysiology of MFD, it is important to examine the broader context, namely, the scientific and medical approach towards dystonias in general. Many ideas in MFD research were stimulated by findings in other types of dystonias; however, due to the evident difference between the circumstances in which symptoms appear, not all might be translatable. In fact, some of these hypotheses have been scrutinised and questioned recently (Sadnicka et al., 2021; Stein et al., 2016), and the general dystonia model's inability to explain why only an individual task is affected is often criticised for resulting in an incomplete understanding and inefficient treatment strategies (Sadnicka et al., 2016; Sadnicka et al., 2018; Stein et al., 2016). Despite these voices in the research community, the bulk of the literature uses the same models for the non-task-specific and task-specific variants of dystonia (e.g., see Lin & Hallett, 2009). The following paragraphs, therefore, explore the

[7] A disorder which appears spontaneously without a detectable, direct cause.

generally accepted, evidence-based theories about the origins and development of the dystonias, and how these ideas were translated to the research of MFD.

Genetic predisposition is a frequently cited risk factor in all types of dystonias (Jankovic, 2006; Siokas et al., 2018), but there is less evidence about this heredity factor in behaviourally induced variants: as Hallett (1998) writes, "the predisposition could be genetic, but the evidence from family studies of focal dystonias indicates that the penetrance is low" (p. 601). Moreover, genes associated with primary and focal/segmental dystonia phenotypes (DYT1 and DYT6) (Gavarini et al., 2010; Klein, 2014) were not typically found in musicians with MFD and a family history of dystonia (Schmidt et al., 2011 as cited by Chang & Frucht, 2013); therefore, subsequent studies have been conducted to explore other possible contributors to the genetic predisposition of the MFD sufferers. Recently, the ARSG gene (arylsulfatase G) was identified as a risk factor for developing MFD (Lohmann et al., 2014); however, Sadnicka et al. (2016) conclude that more data is needed to confirm these associations. Additionally, the role of epigenetics (the impact of the environment on the gene expressions) is under-studied in MFD. Sadnicka et al. (2016) also caution:

> One needs to be cautious about causality in this situation, as, though the genetic makeup of the individual may confer susceptibility to dystonia, it will also, in part, define the motor ability and aptitudes necessary for specific features of the affected task (such as the unique audiomotor interactions required for learning and performing music). (p. 3.)

In terms of underlying neurological processing, with the advancement in brain imaging technologies, scientists have been able to pinpoint certain maladaptive changes in the brains of dystonia sufferers. One of the main findings is that there is decreased inhibition and increased excitability in certain brain regions (Hallett, 1998; Lin & Hallett, 2009). When a task is carried out, inhibiting unnecessary activation is as important as the stimulation of the muscles which complete the action. In the absence of the inhibiting processes, an unnecessary activation can take place, which can debilitate and disturb the primary and intended movement. Decreased inhibition has been shown in FID sufferers at the cortical, brainstem, and spinal levels (Hallett, 1998). Following these findings, many researchers replicated similar experiments with MFD sufferers and suggested that the deteriorated inhibitory processes, especially in the cortical areas, are at least partially responsible for the symptoms (Byl et al., 2000; Candia et al., 2005; Elbert et al., 1998; Haslinger et al., 2010). However, these studies have been criticised for the large variability in their results, and their small sample sizes and it has been pointed out that the decreased inhibition might be a secondary epiphenomenon, rather than the origin of the onset (Sadnicka et al., 2016). Furthermore, it is unclear why only a singular task is impacted by the decreased inhibition in the motor function.

Abnormal brain plasticity has also been found responsible for the onset of different dystonias (Classen, 2003). In MFD, this is explained as the merge of different cortical representations of different body parts, such as finger digits (Elbert et al., 1998). In musicians, the enlargement of these representations is a natural consequence of the prolonged, repetitive fine motor movements associated with instrumental practice (Gaser & Schlaug, 2003); however, it is suggested that in musicians with MFD, this process goes too far, resulting in the deterioration of the control of the movement. These ideas are based on a frequently cited animal model (Byl et al., 1996), where monkeys developed dystonia-like symptoms after repeating a rapid, grabbing movement trained by the research team, but it might not pertain to task-specific movement disorders in musicians as well as previously thought. Playing a musical instrument on a high level is arguably a much more complex activity than repeatedly grabbing a stick (Stein et al., 2016): it greatly differs in terms of the high variability in the performed movements, moreover, it also involves cognitive and emotional elements. Furthermore, similar “overlaps” in the neural representations of parts of the hand are reported in healthy individuals as well (Ejaz et al., 2015), and even if these changes would be responsible for the MFD symptoms, it is unclear why problems with movement control of these body parts only appear when carrying out a specific task. In conclusion, the evidence that sufferers might have abnormal plasticity responses is not explicit, moreover, certain levels of decreased inhibition and increased neuroplasticity might even contribute to the complex motor skills musicians have to perform (Sadnicka et al., 2016).

To gain a clearer understanding of this issue, researchers collected data during a performance task in an fMRI scanner from dystonic and non-dystonic musicians and found no distinct differences between the groups pertaining to the neural finger representations in the primary somatosensory cortex (Sadnicka et al., 2021). The researchers concluded that the neurological disturbance that takes place in affected musicians’ brains is “due to a higher order disruption of skill encoding” (Sadnicka et al. 2021, p. 1), which can better explain the condition’s task-specific nature as well.

Recently, a new neuroscientific model of task-specific dystonias has been proposed, that takes a new, revolutionary approach: instead of understanding these conditions as the disorder of neural function, the symptoms are explained as a compensatory reaction of the healthy motor system (Sadnicka et al. 2018). The theory is based on the process of healthy motor learning and re-centres the focus of the inquiry from brain function to movement acquisition and practice, exposing new contributing factors which might impact the way the movement is learned, practised, and performed. The listed risk factors in this model include biomechanical constraints (i.e., the individual's anatomical parameters might place limitations on the achievable speed and range of the movements), the restraining nature of the task, the required accuracy associated with it, the characteristics of the tool (instrument) used, and the general capacity of the central nervous system (Sadnicka, et al., 2018). This model also aligns with the theories of Grünewald (2007) and Stein et al. (2016) both of which originate the onset from a period of maladaptive learning.

Grünewald (2007) explains that in healthy learning, the muscle spindles[8] encode the force, position, and velocity of the muscle which is then correlated with the movement which takes place; the consistency between this neural and physical activity is essential for creating and reinforcing motor subroutines associated with a task. However, when an individual practises in a fatigued state, it compromises this consistency and the estimation of the parameters of the desired movement, leading to a disordered motor sequence. The idea of the compromised estimation also takes a central role in Stein et al.'s (2016) predictive-control hypothesis: the fatigued performer's inability to recreate the exact same motor output results in discrepancies between the predicted and manifested movement which leads to the deterioration of the brain's predictive control. As Stein et al. (2016) explain, "such deficient predictions impede the CNS's[9] timely selection and activation of the component elements in task-specific movement sequences", leading to the uncontrolled, inefficient, and inappropriate muscular activations observed in focal dystonias.

These ideas highlight the importance of the process of movement learning and repetition and present a new avenue for further research. Moreover, these theories indicate that successful prevention is possible if the premises of movement acquisition are understood, and appropriate tools are used during the process of obtaining the skill.

[8] Muscle spindles are receptors that signal the changes in a muscle's length, i.e., the extent to which it is contracted.
[9] Central Nervous System.

In conclusion, while the current ideas and models provide insights into certain neural changes which might contribute to the symptoms, they cannot fully explain the pathophysiology of the condition, especially its task-specific nature. Following Sadnicka et al.'s (2018) unifying motor control framework, research indicates that it will be necessary to broaden the field of inquiry to understand MFD in-depth, including the process of movement acquisition and performance, which is inseparable from the psychosocial and psychological elements of the educational and work experience. This leads to the next layer of the introduced model: the psychopathology of the condition, which is another unresolved historical debate around dystonias.

2. 2. 2. Psychopathology and the neuropsychiatric model

According to Garcia-Ruiz (2013), the history of the research and treatment of task-specific dystonias is an excellent example of how dominant contemporary views and ideas shape the understanding of a medical issue. The question of whether dystonias are organic or psychiatric has been a topic of heated debate for over a century (Munts & Koehler, 2010). The understanding of the psychopathology of MFD changed many times before reaching the present consensus, and this history significantly influenced the currently used models, and subsequently, the research and treatment of MFD. Therefore, a short overview will be provided of the contemporary theories of different eras to lay out the process through which researchers arrived at the most recent theories.

In the 19th century when the first medical texts about various types of dystonias were written (Hammond, 1876; Gower, 1886), all problems of the Central Nervous System (CNS) were examined, documented, and treated as one disease group (Baker et al., 2002), but around the turn of the 20th century, two very distinct fields emerged: psychiatry and neurology (Rowe, 2010). This specialisation allowed for more detailed research and gave rise to more nuanced expertise; however, it also initiated the idea that the disorders of mood and cognition and neurological abnormalities are completely separate matters (Baker et al., 2002). The sharp distinction between these two fields led to a strict classification, sorting the disorders of the CNS into one of these categories and later, placing these conditions either into the International Classification of Diseases (ICD) or the Diagnostic and Statistical Manual (DSM) (White et al., 2012). This change had a huge – and possibly negative - impact on the diagnosis and treatment of conditions with unexplained or poorly understood somatic symptoms; as Rowe (2010) puts it: "when neurology and psychiatry moved apart from each other around the turn of the 20th century, casualties included the many patients with unexplained neurological disorders" (p. 1295). This new system of classification not only reduced the communication and collaboration between the fields (Baker et al., 2002) but also seemed unable to reliably address some of the complex issues some patients were facing.

Gower (1876) and Hammond (1886) originated occupational cramps from the dysfunction of the CNS and the repetitive nature of the affected task. Subsequently, the rise of the psychoanalytic approach following the work of Sigmund Freud steered the understanding of the many unresolved conditions in the field of psychiatry and psychology (Munts & Koehler, 2010). As a result, until the late 20th century unexplained motor problems, including task-specific dystonias, were mostly treated as a type of "hysteria" due to medical professionals' inability to find any physical cause. The symptom was understood as the somatic expression of an underlying psychological controversy caused by personality and environmental factors as well as predisposition (Crisp & Moldofsky, 1965; Munts & Koehler, 2010), and the premise was that if this inner argument could be resolved, the symptoms would disappear too. This clearly oversimplified approach failed to develop reliable treatment strategies and was heavily criticised after Marsden's (1976) new classification system stated that dystonias are physical illnesses and not the manifestations of a psychiatric disorder (Albanese, 2017). This change placed patients with task-specific dystonias, including MFD, under the care of neurologists and the theory has been upheld and advocated ever since. The symptoms and the pathophysiology are examined from a strict neurological perspective, and potential psychological risk factors are neglected by the bulk of the literature or treated as a secondary reaction to the symptoms (Sadnicka et al., 2016). This led to a poor understanding of the psychopathology of task specific dystonias, such as MFD, which influences the research practices and the administered treatments as well, which largely neglect the psychological problems of the sufferers.

Recently, the progress in brain imaging techniques (MRI, fMRI) produced an overwhelming amount of evidence that patients with psychiatric disorders, such as depression and bipolar personality disorder, have altered neural activity (White et al., 2012) and abnormalities can be detected even on a structural level (Gray et al., 2020; Zhang et al., 2020). As a result, professionals are urged to view these disorders through the lens of functional neuroanatomy and to adjust medical training to align with the most recent understanding rooted in neuroscience (Lane & Potter, 2001).

At the same time, there is growing evidence of co-morbid psychiatric issues in patients suffering from neurological movement disorders (Berman et al., 2017; Conte et al., 2016; Lencer et al. 2009; Semerdjieva & Milanov, 2018). As an example, Lencer et al. (2009) found that there is a lifetime prevalence of psychiatric or personality disorders in 70.9% of Primary Focal Dystonia sufferers (the previous classification of Focal Isolated Dystonias) and suggested re-classifying this group of disorders as “neuropsychiatric”. Despite this newly emerged evidence, the strict separation between neurological or psychiatric disorders is prevalent, and it can make the communication between clinicians difficult, resulting in reduced access to the expertise of the other field (Baker et al., 2002).

White et al. (2012), in the light of the current "revolution in clinical science" (p. 26.) suggest a radical change: merging the fields of neurology and psychiatry and reclassifying the neurological and psychiatric disorders under the domain of "disorders of the nervous system" (p. 27).

While this radical suggestion is debated, the overwhelming evidence inspired researchers to start investigating psychiatric issues in patients with task-specific neurological disorders. The findings align with Lencer et al.'s (2009) data: there is a high prevalence of anxiety, depression, phobias, obsessiveness, and perfectionism in the sufferers of task-specific dystonias, such as the "yips"[10] (Rotherham, 2007), Lost Movement Syndrome[11] (Bennett, 2015), and MFD (Enders et al., 2011; Jabusch et al., 2004; Jabusch & Altenmüller, 2004).

Jabusch et al. (2004) compared musicians with MFD and musicians with chronic pain with healthy controls and found that both groups with performance-related problems displayed higher levels of anxiety than the control group. Additionally, musicians with MFD showed more perfectionistic traits than the other two groups. A follow-up study about anxiety in musicians with MFD (Jabusch & Altenmüller, 2004) produced similar, but even more specific results: the findings show that musicians with MFD suffer from higher levels of social and other types of phobias than healthy musicians and musicians with chronic pain. Enders et al. (2011) reinforced these results, and also found significantly higher neuroticism scores in MFD sufferers than healthy controls using the NEO Five-Factor Inventory (NEO-FFI).

Apart from exploring the prevalence of psychological issues in these affected musicians, their role in the pathophysiology has also been re-examined. Based on

[10] "Yips" is an umbrella term describing various sports-related task-specific dystonias. Among other athletes, it can affect golfers, cricket players, and baseball players.
[11] Lost Movement Syndrome is a task-specific movement disorder affecting gymnasts and trampolinists. It is also referred to as the "twisties".

retrospective questions (Jabusch et al., 2004; Jabusch & Altenmüller, 2004) and retrospective analysis (Enders et al., 2011) it has been suggested that anxieties and perfectionism were present before the onset of the physical symptoms of MFD and can be considered as contributors to the disease progression, rather than a secondary reaction to the onset. However, it is possible that these psychological issues are only present in a sub-group of musicians with MFD. Of 35 patients in Ioannou et al.'s (2014) study, some displayed high levels of anxiety and perfectionism while others did not, forming two distinct groups. While the sample size in this study is small and these results have not yet been replicated, it is an interesting contradiction in the literature, pointing towards a more complex psychopathological model than presented in the previous literature. Nevertheless, it seems certain that at least a portion of MFD sufferers has psychological difficulties that pre-existed before the onset of the disorder, and possibly contributed to it (Altenmüller & Jabusch, 2009; Enders et al., 2011).

There are initial responses to this newly emerged evidence: Altenmüller et al.'s (2014) model (see Figure 2.2.) of the possible risk factors and disease progression includes psychological triggering factors, as well as maladaptive cognitive strategies, such as over-focusing and reinvestment[12]. Sadnicka et al. (2018) also discuss the psychology of motor control and highlight the role of misplaced attention in the development of MFD, at least in a sub-group of patients.

While frequently hypothesised, very little is known about the role of these cognitive processes in the development of MFD and their further implications for rehabilitation. These hypotheses are rooted in observations and different sources and theories about movement

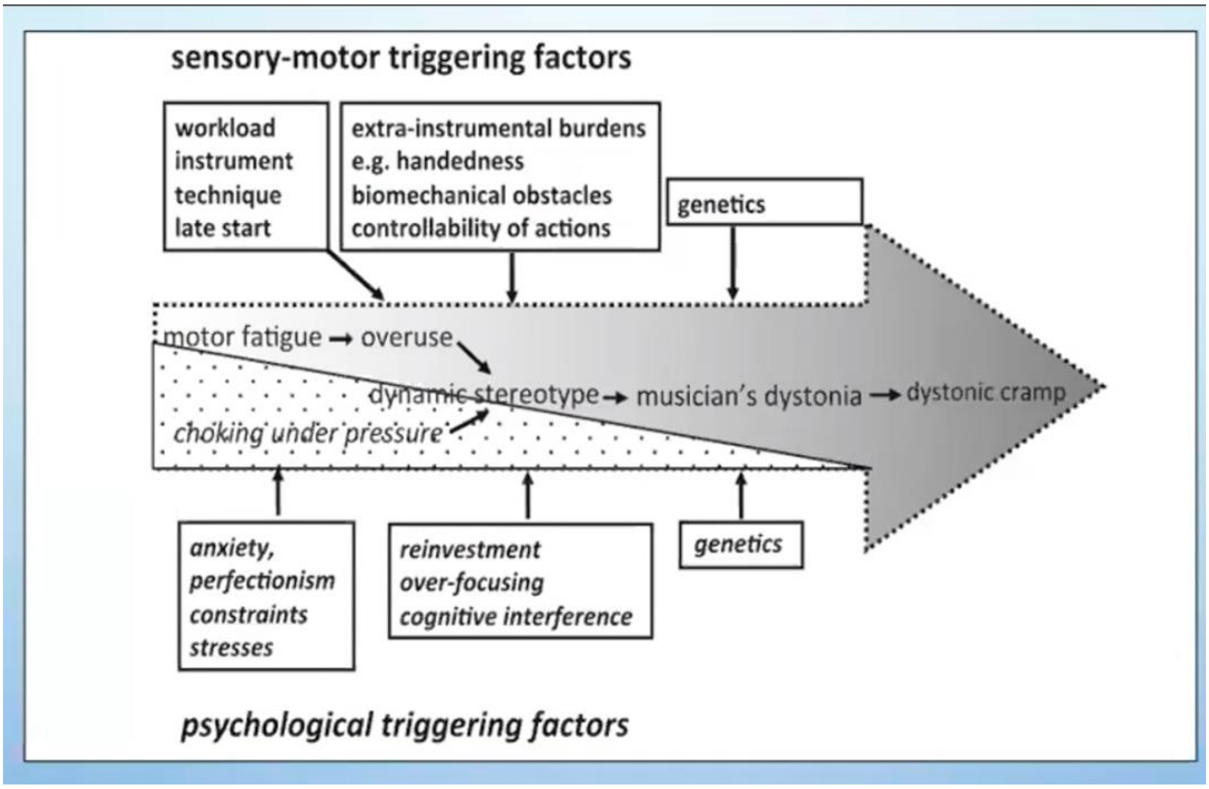
[12] Reinvestment is the conscious manipulation of the biomechanics of an already learned movement during the motor output, i.e., performance.

acquisition and performance. In sports psychology, reinvestment and its detrimental effects on sports performance have been investigated for decades (Deikmann, 1969; Schmidt, 1982; Schneider & Fisk, 1983; Masters et al., 1993; Masters & Maxwell, 2008; Masters, 2012), concluding that cognitive interference with the automatised movement while performing it can obstruct the motor output, and can even lead to complete movement breakdown. Wulf (2013) uses the terminology of "internal focus" when describing the cognitive process that attempts to consciously supervise the movements during the execution, and "external focus" when the attention is directed at the goal of the performed action and concludes that the external focus of attention is superior in terms of movement effectiveness (accuracy and consistency) and efficiency (employed force and muscular activity) (Wulf, 2013). Reinvestment, i.e., internal focus, has also been discussed in relation to task-specific movement disorders and linked to the onset of sports dystonias, such as the "yips" and Lost Movement Syndrome (LMS) (Bennett et al., 2016; Edwards & Rothwell, 2011).

These inquiries were originally conducted in sports settings, but due to the many parallels drawn between sports and music performance (for example, the skill is learned and honed from a young age and performed in high-stress situations), researchers started to investigate these constructs in music settings as well. This exploration is still in its initial phases, given that the first study on the topic was published in 2011 (Duke et al., 2011), but the emerging results align with the findings reported in sports, namely, that externally placed focus of attention is superior to internal focus: it enhances technical precision and even musical expressivity (Mornell & Wulf, 2019). It is reasonable to conclude that the correlation between attentional focus and movement quality remains intact at the other end of this spectrum, i.e., an internal focus would lead to less efficient and less fluent movements during music performance.

Figure 2.2.

Model of the risk factors contributing to the onset of MFD, Altenmüller et al. (2014, p. 171)



There are potential connections between using this maladaptive cognitive strategy and psychological states. As Edwards & Rothwell (2011) observe, anxiety and depression can prompt introspective attention and self-directed focus, which can be furthered by stressful situations, such as performances or competitions. Moreover, perfectionist individuals are more likely to attempt to control their movements to achieve flawless performance (Nilsen, 2019). This suggests a relationship between psychological traits and states and the use of attentional focus, and also demonstrates that cognitive and emotional processes can have a substantial effect on motor output.

In conclusion, the current classification and hypothesised pathophysiology of MFD was heavily influenced by the contemporary views in medicine, which led to an incomplete understanding of the condition. The initial, oversimplified view of the disorder as “hysteria” led to severe criticism after the 1970s, which subsequently deterred the research examining psychological problems as contributors to the condition (Sadnicka et al., 2016). The newly emerged evidence and data, however, suggest that the term “neuropsychiatric” might be a more fitting label for task-specific neurological movement disorders, such as MFD. While there are researchers furthering this field (Altenmüller et al., 2014; Enders et al., 2011; Ioannou & Altenmüller, 2014; Jabusch et al., 2004; Sadnicka et al., 2018; Steinlechner et al., 2018) these are still the initial steps towards a more holistic understanding.

This carries huge importance not only in terms of our theoretical understanding but also from the viewpoint of preventative and treatment strategies. With a more detailed neuropsychiatric model, it would be possible to identify and attend to vulnerabilities in the population, and for musicians with the disorder, this additional information can provide new therapeutic targets.

2. 2. 3. The holistic model

The previous sections discussed in detail why the examination of psychological and psychiatric issues and cognitive functioning are crucial in the case of MFD. The models proposed in alignment with these ideas, however, still have a considerable limitation: they examine psychological and cognitive factors as highly individual traits, even though these do not develop in a vacuum. The social and cultural context in which the individual is embedded plays an important role in the development and cultivation of the personality, psychological traits (Syme & Hagen, 2019), and behaviours (Wulf and Lewthwaite, 2016); therefore, these external (sociocultural and psychosocial) influences should not be overlooked.

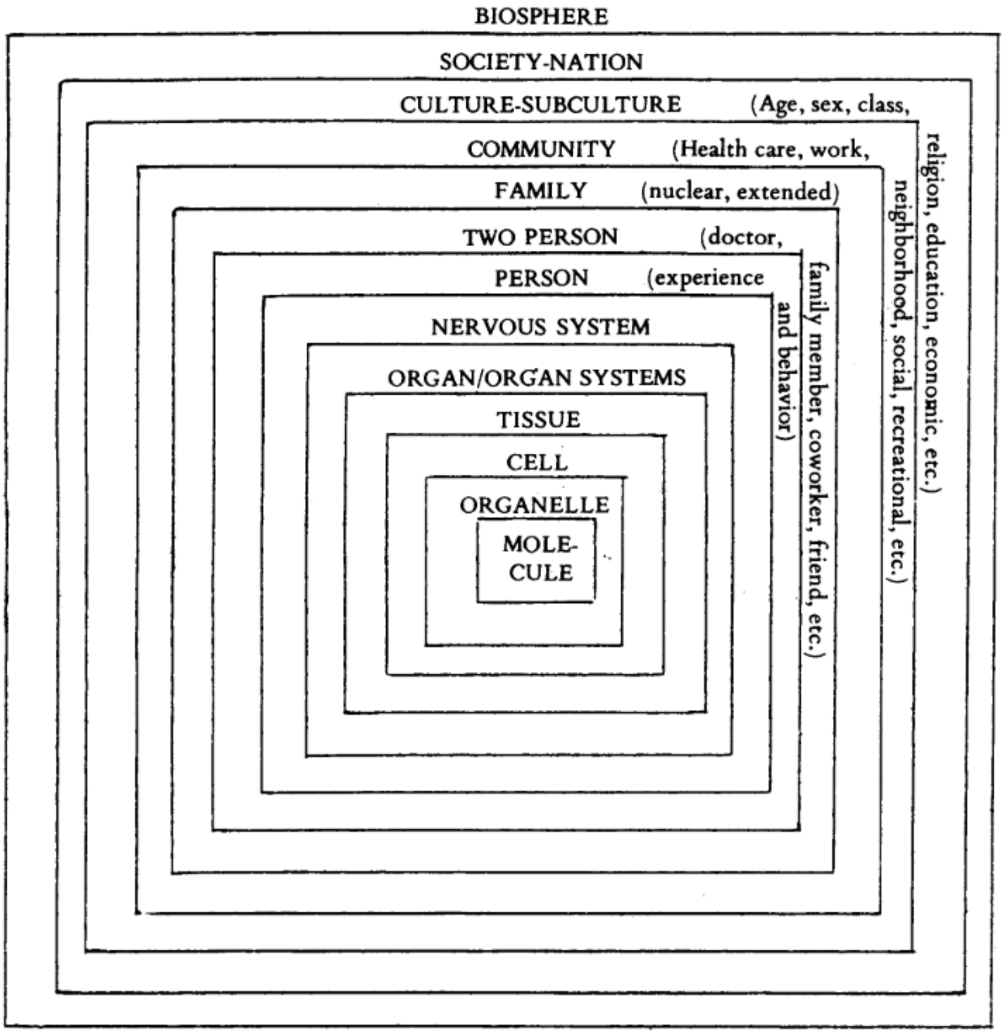
Unfortunately, the study of these important contributors to health and illness are still excluded from traditional medical practices in spite of the frequent and repeated criticisms

(Adler, 2009; Ahn, 2006a; Engel, 1977; Engel, 1981; Syme & Hagen, 2019; Wade & Halligan, 2017). The first landmark paper by Engel (1977) proposed the biopsychosocial model as a replacement for the traditional medical model: this unique understanding converges biological, psychological, and social factors when exploring the aetiology and pathophysiology of various diseases. The model also accounts for the environment in which the studied phenomenon is embedded: as Engel (1981) explains "nature is a hierarchically arranged continuum, with its more complex larger units being superordinate to the less complex smaller units" (pp. 103-104). Similarly to a cell which is part of an organ, or an organ which is part of an organ system, a person is also a part of a higher-level organisational system, such as a family unit, a community, or a sub-culture (e.g., classical musician) (See Figure 2.3). Thus, the study of a single cell cannot provide sufficient information about the complexity of an individual, and an individual cannot be fully understood without their social context. Therefore, Engels (1977; 1981) argues that medical investigations need to be broadened, including the higher levels of the organisational system of which the studied phenomenon is a part to understand the contextual influence.

As Wade & Halligan (2017) explains, the model has lost nothing of its relevance, on the contrary, with the rise of multifactorial chronic illnesses, applying it to modern medicine is imperative. Ahn et al. (2006a; 2006b) also argued the necessity of replacing the traditional, reductionist medical model (which is underpinned by the premise that all complex problems can be solved by dividing them into smaller segments) with "systems thinking". The goal of systems-oriented thinking, similarly to the biopsychosocial model, is to understand the entire system as a whole and not as the sum of its parts, acknowledge that the interaction between parts informs the outcomes, and evaluate many different factors to assess the dynamics of the system.

Figure 2.3.

Engel (1981) Levels of organisational systems



Viewing MFD through the lens of the biopsychosocial model and applying systems-oriented thinking reveals additional justifications to closely examine the role of environmental factors in the onset disorder: the condition is task-specific (Hofmann et al., 2015) and even in the cases where the symptoms spread to further similar tasks, the problems start with instrumental playing (Rosset-Llobet et al., 2007). Therefore, the context in which this action takes place, including the social and educational environment in which the skill is learned and the professional settings in which it is practised and performed, might be a source of important information for understanding the aetiology of the condition.

Task-specific behaviours, i.e., the quantity and quality of the instrumental practice are other topics which are worthy of further investigation. As Adler (2009) points out, behaviours are likely to be informed by the individual's interpretation of the external stimuli; in instrumental learning, examples can include the traditions associated with the environment (Perkins, 2013), feedback from the audience, peers, or authority figures (Avila et al., 2012), and the guidance received to enhance one's skills (Altenmüller & Gruhn, 2002). Given that the repetition of the later affected movement takes the centre of attention in many neurological models (Altenmüller et al., 2014; Byl et al., 1996; Grünewald, 2007; Sadnicka et al., 2018; Stein et al., 2016) examining the characteristics of the instrumental practice and the various factors which might influence it could be informative.

While the current literature only focuses on the quantity of the instrumental practice and the number of repetitions, the quality, i.e., *how* the skill was practised prior to the onset might also provide relevant information. Up to the mean age of the onset, musicians with and without MFD spend the same amount of time practising their instruments (Schmidt et al., 2013); therefore, the differences must be sought in the practice strategies and playing technique. According to Jørgensen (2008), these can be markedly different between musicians, depending on the personality, motivation and attitudes of the musician, the characteristics of the instrument, and lastly, on the social influence, such as communication with the teachers and peers, and the features of the environment where the learning takes place. Differences in instrumental technique might also play a role: it has been suggested that inefficient functional biomechanics and unfavourable playing conditions contribute to performance-related injuries (Allsop & Ackland, 2010; Visentin & Shan, 2004; Visentin et al., 2008), possibly because ill-fitted playing mechanisms can overload certain muscles and joints (Chan & Ackermann, 2014). Even though MFD is a neurological movement disorder, overuse and performance-related pain have been suggested as possible triggering factors (Altenmüller et al., 2014). Moreover, the way the practice is scheduled can also be a possible contributor: whether the musician is taking frequent breaks from the activity or practices in longer blocks might also influence the development of the condition (Sadnicka et al., 2016).

As we lay out this intricate system, it becomes clear why the origin and treatment of the condition resist simple explanations or solutions. The complexity is convoluted even further if, employing the methods of the biopsychosocial model and applying systems thinking to MFD, we consider how these elements might influence and aggravate each other; the impact of the social environment might affect both psychological traits and behaviours; social expectations can be internalised, personality traits might inform the practice strategies, and cognition and emotion can guide movement behaviours. In other words, instead of solely focusing on the somatic symptom and the neural networks supporting (or failing to support) the movement patterns, it is necessary to broaden the field of inquiry and focus on the patient as a whole, acknowledging the social setting in which they are situated in, alongside their experiences, psychological states, behaviours, and feelings, otherwise "the disease, and not the person affected by it, becomes the central focus" (Ahn et al., 2006, p. 0709).

2. 3. Treatment strategies

The previous sections discussed theories and models in great detail; however, little has been said so far about the practical implications. The current understanding was presented as a three-layered model with the narrowest, neurological understanding in the centre, followed by the inclusion of psychological traits and cognitive strategies as contributing factors, and finally proposing a further expansion of this model into a holistic, biopsychosocial model.

The currently used treatment strategies are primarily in alignment with the neurological model, focusing on the motor symptom and its neural representations in the brain. Since the second main goal of this thesis is to enhance the rehabilitation of musicians with the disorder, it is necessary to provide an overview of the available treatment strategies. First, however, one other difficulty needs to be highlighted, namely, the lack of a clear measurement tool to assess the success of the treatment strategies. The two main reviews on the topic (Peterson et al., 2013; Spector & Brandfonbrener, 2007) agree that the lack of a standardised, valid, and reliable measurement tool for MFD is a major impediment in evaluating existing and creating new interventions. There are many difficulties with developing such a scale. Firstly, when talking about a disorder, which means functional abnormality, it is also necessary to define the functional state in detail, otherwise, the differences cannot be outlined. When applying this definition to MFD, the functional abnormality is the impairment of the fine motor movements when playing an instrument, and healthy function is unaffected instrumental technique. However, defining a healthy technique poses a real challenge for many different reasons. MFD is a condition that can affect many different instrumental players and various body parts. The upper extremity is often affected but suffering from symptoms in the orofacial muscles i.e., embouchure (Altenmüller & Jabusch, 2006; Frucht, 2016; Frucht et al., 2001), or the foot (Lee & Altenmüller, 2014) are also prevalent issues. It is clear that the dysfunctions of such different body parts cannot be described in a general way, and it calls for separate identifications. Moreover, the instrumental technique consists of a wide variety of complex movement patterns which can be either fully or partially affected (Frucht, 2016; Jankovic & Ashoori, 2008; Sadnicka et al., 2016; Tubiana, 2003). The performance of these movement patterns is also highly dependent on the educational approach the musicians were taught with (Waters, 2000a; Waters, 2000b). These approaches can differ greatly, resulting in different playing techniques, which are then further modified by the individuals. These changes are sometimes led by personal preferences, but physical differences can also play a major role to use certain techniques. As an example, brass players with different jaw structures and bites might employ slightly different lip positions (Woldendorp et al., 2016). These factors greatly complicate the assessment of the symptoms and the improvement following an intervention, and most often, self-report is used to evaluate the patient. The only method which reliably quantifies the severity of the symptoms of affected pianists was presented by Jabusch et al. (2004): they analysed the velocity of the used keys and timing parameters during the performance of a scale in affected and healthy pianists. However, this method only allows the measurement of playing scales on a piano, excluding other instruments, and other possible playing techniques on the piano as well.

In most studies and practices, researchers, clinicians, and practitioners are relying on the subjective perception of the musicians to evaluate the improvement, which can be influenced by personal and interpersonal factors. Moreover, if a significant amount of time has already been spent on rehabilitation, musicians tend to judge their improvement more positively (Van Vugt et al., 2014). Therefore, the reported success rates of each therapy need to be treated with caution.

2. 3. 1. Medical treatments

Currently, the administered medical treatments are in alignment with the official classification, and mostly follow the protocol which is informed by the treatment of other types of dystonia. The majority of these therapies are either aimed at muscular symptoms, such as Botulinum Toxin injections (Altenmüller & Jabusch, 2006), or at the affected circuits in the brain itself, in the form of oral medication (Altenmüller & Jabusch, 2006) or deep brain stimulation (Horisawa et al., 2019).

The most frequently used approach is Botulinum Toxin injection therapy to weaken the overactive muscles which are causing the cramps and tremors. This treatment is symptomatic since the problem is neurological, not muscular, and was adopted from the treatment practice of non-task-specific, more severe and extreme forms of dystonias, such as generalised dystonia (Jankovic et al., 1990; Jankovic, & Brin, 1991, Rivest et al., 1991). These conditions are characterised by constant and painful symptoms, which interfere with the patients' everyday activities and have further implications on their well-being (Ben-Shlomo et al., 2002); therefore, deterring the over-activation results in relief in the patients. In task-specific dystonias, such as MFD, wherein the majority of the patients, the problem does not manifest in the absence of the triggering task (Hofmann et al., 2015) and the sufferer will continue attempting to execute the fine motor movements associated with the task the outcome might not always be profitable.

Among task-specific dystonias, Botulinum Toxin was first used for Writer's Cramp (Cohen et al., 1989; Rivest et al., 1991) and was administered to musicians with MFD soon after (Cole et al., 1991). It was concluded that while it reduced the spasms associated with the disorder, it did not help regain the lost motor coordination (Cole et al., 1989); Tubiana (2003) commented on these findings in the following way: "we do not think that administration of botulinum A toxin, without neuromuscular rehabilitation, should be an option for musician's FD" (p. 169).

From two big cohorts of musicians with dystonia, 57% (Jabusch & Altenmüller, 2006) and 36% (Schuele et al., 2005) reported long-term improvement in their motor coordination after receiving Botulinum Toxin injections, but there are no documented cases of a full recovery following the treatment. Also, this improvement is only observed in musicians with upper extremity dystonia; wind players with embouchure dystonia are generally not responding well and can even experience deterioration in their motor movements (Schuele et al., 2005). The other main issue with Botulinum Toxin as a treatment for MFD is the expertise required to administer it: as Grünewald (2007) observes “the results of EMG guided botulinum toxin treatment of arm dystonia may be disappointing or associated with unacceptable adverse effects, and the clinical skills required to undertake it are not universally available” (p. 914). The success of the treatment is highly dependent on the precision in localising the affected muscle, and on the injection technique used (Jabusch & Altenmüller, 2006). The injections given based on only visual examination reach the target muscle only in 37% of the cases in the treatment of Focal Isolated Dystonia (Molloy et al., 2002), and this problem is furthered in MFD patients because the disordered movement patterns are often complex and have pronounced compensatory elements which are sometimes hard to distinguish from the primary dystonic symptoms (Jabusch & Altenmüller, 2006). Moreover, to maintain the weakening effect of the toxin, the injections have to be repeated, but the prolonged use might lead to muscle atrophy (Salari et al., 2018), making subsequent behavioural therapy or physiotherapy even more challenging.

In summary, Botulinum Toxin injections are symptomatic and do not offer long-term rehabilitation (Tubiana, 2003). Even when the use is justified, the treatment needs to be complemented with other forms of physical rehabilitation, such as neuromuscular re-education programs or physiotherapy (Tubiana, 2003).

Trihexyphenidyl is often favoured in the treatment of musicians with MFD; this drug is generally used for various conditions to improve motor control, particularly Parkinson’s disease (Jilani et al., 2021); currently, there are no drugs available specifically developed for task-specific dystonias. Similarly to Botulinum Toxin, various drawbacks were reported, particularly, a high percentage of unresponsiveness and in other cases, severe side effects (Jabusch, & Altenmüller, 2006; Jabusch et al., 2005). Jabusch & Altenmüller (2006) reported the outcome of the treatment in 69 musicians; 39 (56.5%) patients dropped out at various points in the treatment due to unsatisfying responses or side effects (e.g., dry mouth, fatigue, dizziness) while 23 (33%) reported some improvement; however, none of the musicians with embouchure dystonia experienced any benefit. Interestingly, those patients who responded to the treatment reported side effects more often as well. Jabusch & Altenmüller (2006) concludes that in their sample, the employment of the drug "was limited due to the frequent occurrence of side effects" (p. 2014).

Deep-brain stimulation is not a widely used method for treating MFD, it is more common in more disabling forms of dystonia, such as generalised dystonia (see Kupsch et al., 2006). Some studies are reporting positive results in musicians with MFD (Cho & Hallett, 2016; Horisawa et al., 2019) but the practice is not widely used, and the literature is scarce. Arguably, with other possible treatments available, the highly risky and expensive invasive brain stimulation does not seem an ideal option, especially since MFD might be crippling in many ways, but it is not life-threatening.

2. 3. 2. Behavioural therapies

Behavioural therapy is an umbrella term, used in this thesis to describe various approaches which re-educate the movement patterns of musicians while they are playing (or attempting to play) the instrument. The literature on these various approaches advanced significantly in the last decade, mostly describing strategies for rehabilitating task-specific hand dystonias (Enke & Poskey, 2018), including constraint-induced therapy[13] (Berque et al., 2010; Berque et al., 2013; Candia et al., 1999), slow practice (Berque et al., 2013; Sakai, 2006), and neuromuscular re-education programs (Byl et al., 2003; Enke & Poskey, 2018). There is

[13] Constraint-induced therapies are based on blocking the unwanted compensatory movements of the healthy fingers with splints.

evidence that the process of aided re-learning not only helps regain control over the affected movements but also encourages positive neuroplasticity which alters the somatosensory cortical representations (Candia et al., 2003; Yoshie et al., 2015). In other words, behavioural therapies can change the neural networks underpinning the activity and have the ability to decrease or erase the dystonic symptom. These therapies have no side effects and are more efficient than other approaches (Altenmüller & Jabusch, 2006; Jabusch et al., 2009).

The tested treatments reported in the literature use a diverse set of strategies to achieve better movement control in musicians with MFD. Some practices start the rehabilitation with general alignment (Tubiana, 2003) and attend to the biomechanics of larger structures (e.g., trunk, scapula, arm movements) (Ackermann & Altenmüller, 2021). Improving general fitness and introducing an exercise protocol as part of the rehabilitation have also been used (Byl et al., 2009; Byl et al., 2000) as components of the therapy. Other programs exclusively target the affected body part by supporting the movement with the use of splints (Berque et al., 2010; Berque et al., 2013; Candia et al., 1999; Rosset-Llobet & Fàbregas-Molas, 2011), or slowing the affected movements down (Sakai, 2006; Yoshie, 2015). Sensory-motor retuning is also a frequently used method which aims to enhance tactile sensations as well as fine motor movement control in musicians with MFD (Butler et al., 2018; Candia et al., 2002; Rosenkranz et al., 2009), and these various components are often combined to approach the problem from different angles at the same time.

Despite these efforts, the outcomes of behavioural therapies are still not satisfactory (Enke & Poskey, 2018) and they are not available for all musicians: the primary focus is the dystonias of the upper extremities leaving musicians with embouchure dystonia or other types of MFD with fewer options; to the best of my knowledge, there are no guidelines or suggestions given in the literature about how to approach the rehabilitation of these phenotypes. Moreover, the patients’ psychological traits, behaviours, and general situation is rarely considered; the therapies focus exclusively on the motor symptom.

Given that these approaches rely on the active participation of the sufferer (Altenmüller & Jabusch, 2010), in fact, the bulk of the work is done by the patient in private practice sessions, the importance of understanding the contributing non-organic factors, especially negative psychological tendencies, increases considerably. The re-learning usually takes years and requires the musician to practice small technical elements meticulously which were already mastered before the onset of the condition (Enke & Poskey, 2018; Tubiana, 2003). There is no research available about how to support this strenuous process, but it is possible that considering the role of psychological, psychosocial, and environmental elements, which aggravated the onset in the first place and addressing them alongside the motor symptom might improve the success rates of these types of treatments.

Psychological traits, previous experiences, the psychosocial environment, and the behaviours prompted by these can influence how the musician acts as an active participant during the rehabilitation, which can impact the outcome of the process (Ioannou & Altenmüller, 2014). In order to create a more reliable protocol, all these elements need to be understood and described. This goal cannot be achieved from the current, strict neurological perspective; a biopsychosocial approach would be more fitting to understand and address the various problems the affected musicians are facing.

2. 4. Conclusion

Since the first documented case of Robert Schumann’s task-specific finger dystonia, MFD has impacted countless musicians around the globe. Compared to other professions affected by task-specific dystonia, musicians are at the greatest risk to develop the disorder with an estimated 1% of the population affected (Altenmüller & Jabusch, 2010). As Schmidt et al.

(2013) point out, this means thousands of musicians, given that there were 176200 registered professional musicians in 2012 in the USA alone.

Our understanding evolved greatly in the last decades with the rapid development of neuroscience, but these advancements did not yet lead to the establishment of a reliable treatment protocol. In similar unexplained and chronic diseases, the research and treatment slowly turn towards a more holistic, biopsychosocial approach, and employs systems thinking instead of the traditional reductionist medical model (Adler, 2009; Ahn et al., 2006a; Ahn et al., 2006b; Syme & Hagen, 2019; Van der Kolk, 2014; Máté, 2011; Wade & Halligan, 2017). Researchers have already started exploring other performance-related problems in musicians in a broad and holistic way, examining the psychosocial environment (Akel & Duger, 2007; Détári et al., 2020; Holst et al., 2011; Jacukowicz, 2016), psychological traits (Chelkowska-Zacharewicz et al., 2021; Kemp, 1993; Kenny et al., 2014; Lawendowski et al., 2020), practice and playing behaviours (Ericson et al., 1993; Visentin & Shan, 2004; Visentin et al., 2008), the role of music education (Patston, 2014; Presland, 2005; Waters, 2020a; Waters, 2020b), and learning cultures of musicians (Perkins, 2013) in relation to health and wellbeing. These inquiries led to a more detailed understanding and various interventions to support injured musicians and the development of preventative programs. Following these examples and initiatives, approaching MFD in a similar way could enhance both treatment and prevention.

While some of the more recent models acknowledge the presence of maladaptive psychological traits and cognitive strategies, there is still a certain level of reluctance to include these factors in the pathophysiology of the condition (Sadnicka et al., 2016) and the suggested research trajectory aligns with the traditional neurological model (Richardson et al., 2017). Even less is known about the practice behaviours of the musicians prior to the onset, which can be a piece of crucial information given the symptoms are most often restricted to the specific movement patterns associated with the instrument (Hofmann et al., 2015). And lastly, there are hardly any mentions of how these possible contributing factors evolved in the musicians and the role of the social environment in the process.

This thesis is an initial exploration of the disorder from a more holistic perspective by focusing on the musician with the disorder rather than just the affected body part. To reach this goal, an inductive and phenomenological approach was taken, placing the lived experience of the musicians with the disorder in the centre of attention, especially their recollections of their personal and professional lives prior to the onset. Opposing the primarily used deductive methods where preconceptions were tested, this approach allows exposing previously hidden aspects of the condition, which then can be tested in a more generalising, quantitative way subsequently. The research questions guiding this research were the following:

1. What were the characteristics of musicians' personal and professional live prior to the onset of MFD?
2. How did these factors potentially influence the development of the symptoms of the disorder?
3. How might these factors influence the rehabilitation from the condition?
4. Based on the acquired information, what steps could be taken to protect the next generation of musicians from the disorder?

To answer these questions, three studies were planned with a mixed methodology. The first Constructivist Grounded Theory study allowed data to emerge directly from the source: the stories and recollections of musicians with the disorder. In these open interviews, participants could share their narratives without being restricted by conceptual frameworks, which led to rich data and concepts previously unexamined in relation to MFD. The second study was constructed based on this information; while it still used personal opinions and observations as a source, the target population of the inquiry was practitioners who work with affected musicians frequently. These experts' narratives allowed access to a very large in-direct sample of musicians with MFD, but the data still carried the nuance of personal experience. This study also offered insight into the ongoing practices and the additional tools used to support this vulnerable population. The third stage of the thesis was a hypothesis-testing questionnaire study with the goal of exploring the frequency of the risk factors identified by the first two studies. The data obtained from the three phases of the research was then subsequently used to generate a holistic model of the condition and make recommendations for enhancing treatments and developing preventative strategies.

Chapter 3. Methods

3. 1. Epistemology and methodological approaches

MFD is a complex phenomenon, which eluded all attempts to fully understand and reliably rehabilitate the condition. The multifaceted and complex web of potential contributing factors is generally acknowledged in the literature (Altenmüller & Jabusch, 2009; Sadnicka et al., 2016; Sadnicka et al., 2018); however, not all areas are given equal thought and attention. Excessive research has been undertaken to identify genetic factors (Lohmann et al., 2014; Schmidt et al., 2009; Schmidt et al., 2011) and to understand neural changes which take place in the affected musicians' brains (Candia et al., 2005; Haslinger et al., 2010; Sadnicka et al., 2021). Much less, but increasing attention has been directed towards psychological characteristics, cognition, and to a certain extent, emotive elements (Enders et al., 2011; Ioannou & Altenmüller, 2014; Jabusch & Altenmüller, 2004; Jabusch et al., 2004). Research into the role of lifetime prevalence of traumas is in its initial stages (Alpheis et al. 2022; Schneider et al., 2021) but the frequently reported traumatic events preceding the onset of the condition (Schmidt et al., 2013) are under-researched. Moreover, very little is known of the biomechanical aspects of the condition, even though postural deficits seem typical in this population (Tubiana, 2003), and to the best of my knowledge, no research has been undertaken to explore the broader social context in which the later affected skill was learned and practised. In conclusion, several topics associated with the condition were only theorised or there is only anecdotal evidence to link them to the onset; therefore, they need to be examined in more detail, furthermore, the potential links between these factors need to be considered.

The research which is being undertaken on the topic - with only a few exceptions (e.g., Schneider et al., 2021) - has methodological similarities: MFD is approached in a deductive manner, from the highest conceptual level towards the details, and is conducted within a positivist and reductionist framework with quantitative methodological tools. This positivist epistemology states that knowledge can be gained by empirically observing and measuring phenomena, and based on this knowledge, it builds models to describe reality (Fox, 2008). However, while a positivist framework can be an excellent tool in natural sciences to generate knowledge, it has also been criticised for disregarding human experiences and interpretations and attempting to establish a general “truth” without considering the context (Fox, 2008). The reductionist approach furthers this simplification by focusing only on small segments of the phenomenon in isolation, disregarding potential links between them and their contextual influence (Ahn et al., 2006a; Engel, 1977; Wade & Halligan, 2017).

As Johnson & Onwuegbuzie (2004) point out, research areas which are dominated by one particular methodological approach, often benefit from methodological pluralism, i.e., a mixed-methods research strategy. Every methodological tool has its strengths and weaknesses, and by using primarily one approach in the majority of the conducted studies on a topic, the bias associated with the design can impact the generated models, resulting in a restricted overall understanding. By using a mixed-method approach, the researcher can “draw from the strengths and minimize the weaknesses” (Johnson & Onwuegbuzie, 2004, pp. 14-15) of both qualitative and quantitative designs, and produce a more detailed and accurate understanding of the studied phenomenon.

Studying a subject by applying a mixed-method approach, however, raises epistemological questions, namely that the methodological approaches are rooted in different philosophical assumptions about the nature of reality. The epistemological standpoint of qualitative studies is that knowledge is constructed as a result of the interaction between the researcher and the subject of their study, an assumption known as constructivism. This acknowledges the fact that social reality is not an objective entity but emerges from the individual and collective norms, values, and belief systems (Fox, 2008). Quantitative enquiry, on the other hand, operates within the aforementioned positivist framework, postulating the existence of objective reality.

This evident difference between the epistemological approaches of the elements in mixed-method studies has been excessively discussed in the literature (Biesta, 2010; Descombe, 2008; Johnson & Onwuegbuzie, 2004). The consensus in the field regarding the philosophical and epistemological differences is that the "rationale for a mixed-method approach needs to be a pragmatic one" (Biesta, 2010, p. 96.), in other words, the level of success of the practical application of the methodology should inform the methodological choices rather than underlying philosophical principles. Biesta (2010) argues that while pragmatism cannot fully provide philosophical support for mixed methodology research, John Dewey's theory of knowing (1933) can help us solve this conflict in epistemology (Biesta, 2010); Dewey argues that since obtaining knowledge is always the result of some form of action, the gained information is generated by the interaction between the procedure and its consequences; therefore, it should not be viewed as a "once-and-for-all truths about a world independent from our lived lives" (Biesta, 2010, p. 96), no matter what tools were used in collecting the data.

The epistemological approach of this thesis aligns with this pragmatist view situating the research between objective positivism and subjective idealism, in other words, acknowledging the co-existence of individual realities influenced by personal experiences and the social environment and the presence of measurable trends and tendencies in a broader context. By doing so, the aim is to generate and promote tangible and practical outcomes for the community of musicians with MFD and practitioners working with them, in addition to informing preventative strategies.

Mixed-method research has various tools to generate and obtain knowledge: induction (drawing conclusions directly from the data), deduction (testing hypotheses), and abduction (selecting the best interpretation of the results) (Johnson & Onwuegbuzie, 2004). Given the multifactorial nature of MFD and the lack of detailed understanding of many of these factors, this research starts with induction, i.e., seeking patterns in the life experiences of musicians with MFD, followed by the observations of those who work with them frequently. These findings can then be narrowed down to a more specific set of risk factors to be examined in a positivist framework with quantitative methodology.

3. 2. The mixed-method study design

The epistemological considerations and the state of the art prompted a mixed-methodology design which allows the strengths of both qualitative and quantitative research methods to inform the final results of the thesis. This methodological design had three phases: an exploratory, a verifying, and a generalising stage; the corresponding studies are building on each other, each guided by the findings of the previous one. After the conclusion of the third study, the generated data was used to perform a triangulation between all the data points, leading to a more nuanced and valid picture of the phenomenon (Torrance, 2012). Here, a short overview will be provided of each study to outline the overarching methodological design; more detailed information about the data collection, participants, and analysis of the studies is presented in Chapters 4-7.

The first conducted study was a constructivist and exploratory Grounded Theory design: this methodological tool allows researchers to map previously uncharted areas and create a broad understanding of the field (Charmaz, 2006). The themes and categories emerge directly from the data, as the researcher is collecting and analysing it simultaneously. New findings are tested in the subsequent interviews to the point where the data reaches saturation, i.e., there are no new topics emerging. This dataset consists of the narratives of individual musicians suffering from the condition and can be described as very subjective and personal.

To broaden this understanding, the second study presented the emerged topics to practitioners (neurologists, psychologists, physiotherapists, and private practitioners) who frequently work with sufferers of MFD in the form of semi-structured interviews, which also allowed new insights to emerge. The data generated by this study is still subjective, but less personal since the interviewees were sharing their observations of an estimated 2000 affected musicians they have treated or interacted with. This indirect large sample provided an insight into the ongoing practices and the participants' professional and personal opinions about their patients/clients. The participants were also asked how they addressed the non-motor symptoms in their practice; these findings were subsequently used to inform the discussion about treatment strategies.

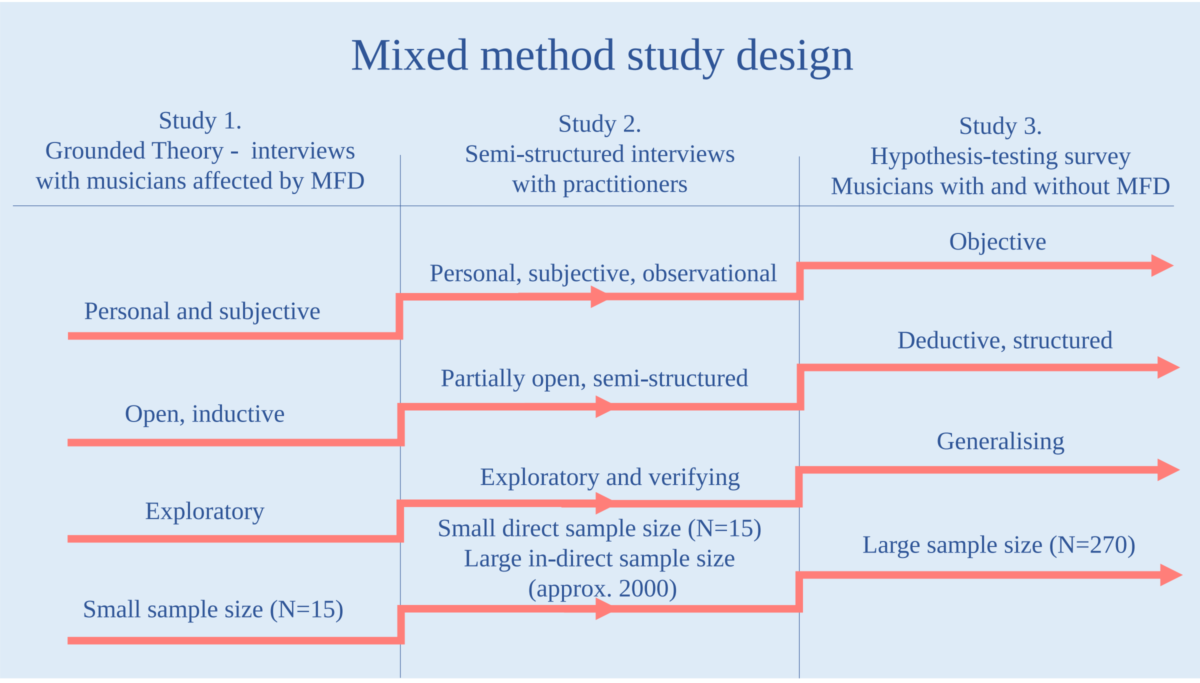
The third phase of the research was a hypothesis-testing questionnaire study, which aimed to generalise a set of risk factors (chosen from the rich qualitative material) by comparing musicians with MFD with healthy musicians. Since there were many different themes and topics in the dataset of the first two interview studies, a process of careful selection was performed. To optimise the process of this selection, all the themes and topics were tested against a set of criteria, which was set up to ensure that the areas of most interest were explored. These were not considered with equal weight, the order in which they are presented also shows their rank in importance.

1. Themes that were strongly supported by both interview studies.
2. Themes that were unexplored by previous literature.
3. Themes that were supported by anecdotal evidence mentioned in previous literature.
4. Themes that could be linked to previously established concepts and validated scales were available.

An overview of the studies and their characteristics and the trajectory of the research is presented in Figure 3.1.

Figure 3.1.

Study design



3. 3. Analysis and triangulation

Analysing and triangulating the findings of a mixed-methods research study requires certain methodological considerations, namely, the implementation, priority, integration, and theoretical perspective (Creswell, 2003). The implementation of this design was a sequential one: the studies were conducted separately, followed by the data analysis and interpretation. Since all of them can be viewed as individual pieces of work, they are more loosely connected than data collected by different methodological tools within the same study; however, the findings informed and guided the methodological choices made in the subsequent studies.

Priority was given to the qualitative data over the quantitative data in the overall analysis in cases where the findings were pointing towards opposing concepts. The main reason for this is the lack of validated measurement tools in the areas of the inquiry; the questionnaire study used many self-constructed tools which need refining in the future and the validity at this point cannot be guaranteed.

The integration of the data in mixed methodology studies is often labelled as triangulation, and it is one of the most important processes since it informs the final emerging model (Fielding, 2012; Torrance, 2012). This process was also sequential in the overarching design, given that the findings of each study informed the design of the following one; however, at the conclusion of the research, as presented in the general discussion in Chapter 8., a second level integration was performed within the established framework to refine the final model.

According to Creswell (2006), there are two main attitudes that can govern the theoretical approach: either the theoretical perspective informs the analysis from the beginning, or it is emerging as the research proceeds. In this design, the framework which later guided the analysis developed during the first, exploratory stage, namely, the Grounded Theory study, and informed the subsequent studies.

3. 4. Researcher reflexivity

I am a professional musician with a BA and MA performance degree in flute performance. I was leading a successful freelancing soloist career until the onset of a severe case of embouchure dystonia in 2010: following an extremely rapid onset, I completely lost my ability to produce a sound. My full recovery was a result of an unaided and self-led retraining, and I returned to my performance career in 2014. After my recovery, I soon learned that opposing my original belief that this was an incredibly rare problem, a large number of musicians were suffering from it in my close proximity. When I started talking openly about my experience, countless colleagues, students of colleagues, former teachers, and peers told me in private that they were experiencing MFD symptoms. I heard many stories about ending careers, miracle cures which did not work, and financial and mental health issues, and it became clear that there is no reliable treatment, and no resource or support available to these musicians.

My own experience and the apparently desperate need for better approaches inspired me to continue my studies to understand the situation better. I completed an MSc Performance Science degree at the Royal College of Music in 2018, and I continued my research at the University of York as a PhD candidate. Alongside my academic studies and inquiries, I became a member of several online support groups and have frequent communication with musicians with the condition, and private practitioners work with them to rehabilitate their skills.

Thus, my personal and professional experience, both as an active musician and as a former MFD sufferer puts me in a position that Dwyer & Buckle (2009) describes as an “insider status”. The fact that I was forced to quit my performance career for four years due to my inability to play was openly communicated to the participants of this research which possibly allowed me to build rapport with my interview participants quickly. As Dwyer & Buckle (2009) puts it, when the researcher is perceived as part of the group, “the participants are typically more open with researchers so that there may be a greater depth to the data gathered” because there is an “assumption of understanding and an assumption of shared distinctiveness” (p. 58). Conducting research from this “insider view” also carries potential problems. As Brannick & Coghlan (2007) articulates, insider research is often viewed as too subjective and is a risk to the intellectual rigour expected from academic research. Moreover, it can result in confusing one's role as a researcher and as part of the group and interpreting the data through the lens of one's personal experiences.

I concluded that this bias cannot be completely eliminated from the research; therefore, acknowledging it in a transparent way is the best course of action to preserve the authenticity of the work. As Adler & Adler (1987) noted, complete objectivity in qualitative research is not achievable and instead of aiming to establish it, researchers need to focus on the advantages stemming from the insider status (Dwyer & Buckle, 2009) and use epistemic reflexivity (examining one's belief systems and preconstructed assumptions) and methodological reflexivity (monitoring the impact of the study design and setting on one's behaviours) to ensure the clarity of the process (Brannick & Coghlan, 2007). The close supervision and feedback from external resources (e.g., supervisor, Thesis Advisory Panel) were also invaluable to guide this research and encourage the development of a deeply reflective practice.

3. 5. Ethical considerations

In this research, three main groups of participants were targeted: musicians with MFD (in Studies 1. and 3.), musicians who do not suffer from the disorder (in Study 3.), and practitioners who treat the condition frequently (in Study 2.). The different characteristics of each of these groups require distinct ethical considerations; therefore, they will be discussed separately in the following paragraphs.

Undoubtedly, musicians with MFD are the most vulnerable of these three groups, especially because they were asked to share various details about their disorder during the data collection. MFD is a condition which can have a devastating psychological, emotional, and financial impact on the affected individuals. These musicians often spend decades of their life with diligent and dedicated work to hone their skills on their chosen instrument before the onset (Chang & Frucht, 2013; Conti et al., 2008), tying their identity to the profession (Toner et al., 2016) only to lose it in an unexpected and unexplained way. The lack of reliable rehabilitation strategies and their inability to continue their professional career in the same manner can further this distress, leaving them in a vulnerable state. Therefore, when collecting data from this population, these ethical considerations directed the inquiry throughout.

There is a less pronounced risk of causing psychological distress in healthy musicians when inquiring about their personal experiences; however, since musicians, in general, are more prone to suffer from mental and physical issues than the general population (Kok et al., 2016; Vaag et al., 2016) and work in less optimal environments (Détári et al., 2020), the risk might still be substantial.

The participants who work with affected musicians were recruited from two separate groups: medical professionals and private practitioners. While they were asked about their experiences with their clients, personal memories and experiences were inevitably part of the conversation. All private practitioners were former sufferers of the disorder, now fully recovered, and three of the medical professionals had personal experiences with the condition. Apart from the personal involvement and the potential distress stemming from the recollection of upsetting events from their past, there was another important ethical consideration to make: there are only a few individuals who specialise in treating the condition; therefore, these participants could be easily recognised by someone relatively knowledgeable on the field, based on very little information.

To ensure the best practice in all three groups, ethical approval was obtained by the Conservatoires United Kingdom Research Ethics Committee (Study 1.) and the Arts and Humanities Ethics Committee at the University of York (Study 1., 2., and 3.), and all studies adhered to the guidance of the British Psychological Society's *Code of human research ethics* (2021). The ethical considerations regarding each study will be discussed under the four principles put forward in this document:

1. Respect for the autonomy, privacy, and dignity of individuals, groups, and communities
2. Scientific integrity
3. Social responsibility
4. Maximising benefit and minimising harm.

3. 5. 1. Respect of autonomy, privacy, and dignity of individuals, groups, and communities

The BPS code of ethics states that the researcher needs to "respect the knowledge, insight, experience, and expertise of participants and potential participants" (British Psychological Society, 2021, p. 7). The research was conducted based on this principle with the goal of acquiring details about the personal experience of the participants without imposing premeditated ideas or concepts on them. Due to the objectives of the research, the sampling was selective: in Study 1., the data was obtained from musicians who were diagnosed with MFD, in Study 2., participants were invited based on their expertise and experience, and in Study 3., musicians with or without MFD were invited to take part. In all studies, it was ensured that all participants who met the inclusion criteria were welcomed to participate in the research, e.g., both in-person and online appointments were made available for the interviews and the survey was administered online. Privacy was ensured by anonymising all the data: in the interview studies all pieces of information about locations, names of individuals, and institutions were deleted. Additionally, in Study 2., the anonymity of the practitioners was protected by withholding information about their gender and their job titles; given that the group of people specialising in MFD is relatively small, more information could have potentially compromised the anonymity of these individuals.

3. 5. 2. Scientific integrity

The BPS code of ethics articulates that “research should be designed, reviewed and conducted in a way that ensures its quality, integrity and contribution to the development of knowledge and understanding” (p. 8). The methodological design of this thesis was developed under the close supervision of the advisory panel and the supervisor to optimise the outcome of the work. The analysis and interpretation of the data were also closely followed by the supervisory team to ensure the rigour of the conducted research. The resulting work contributes to a more holistic understanding of MFD with further implications for music education, preventative strategies, and MFD treatment.

3. 5. 3. Social responsibility

The BPS code of ethics defines the aims of social research as generating knowledge and data that “support beneficial outcomes” and “have potential to contribute to the ‘common good’” (p. 8). A better understanding of the potential risk factors in developing MFD and the resulting non-motor symptoms of musicians with the disorder directly contributes to the development of preventative strategies and the enhancement of treatment approaches, thus, assisting the efforts of music educators, researchers, and practitioners in enhancing the welfare of musicians.

3. 5. 4. Maximising benefit and minimising harm

According to the BSP code of ethics, researchers should “value their responsibilities to persons and peoples, to the general public, and to the profession and science of psychology, including the avoidance of harm and the prevention of misuse or abuse of their contribution to society” (p. 9). Participants with MFD were asked to recall events from their lives which were potentially distressing. Therefore, potential risks were carefully mapped and assessed before the data collection and to mitigate these risks, and following the BSP code of ethics' recommendations, participants were approached with compassion and sensitivity. Additionally, both in Studies 1. and 3., they were directed towards resources to support their mental and physical health.

3. 6. Summary of the chapter

This chapter introduced the epistemological considerations and the methodological design of the mixed-method study design, including an overview of each stage of the research. The process of data analysis and the triangulation of the data was discussed. My position as the researcher was contextualised and the developed reflective practice was described, followed by the ethical considerations. The next four chapters (4-7.) present the findings of the three empirical studies conducted for this research.

Part II. Empirical studies

Chapter 4. Study 1. - The musician's perspective

4. 1. Aims

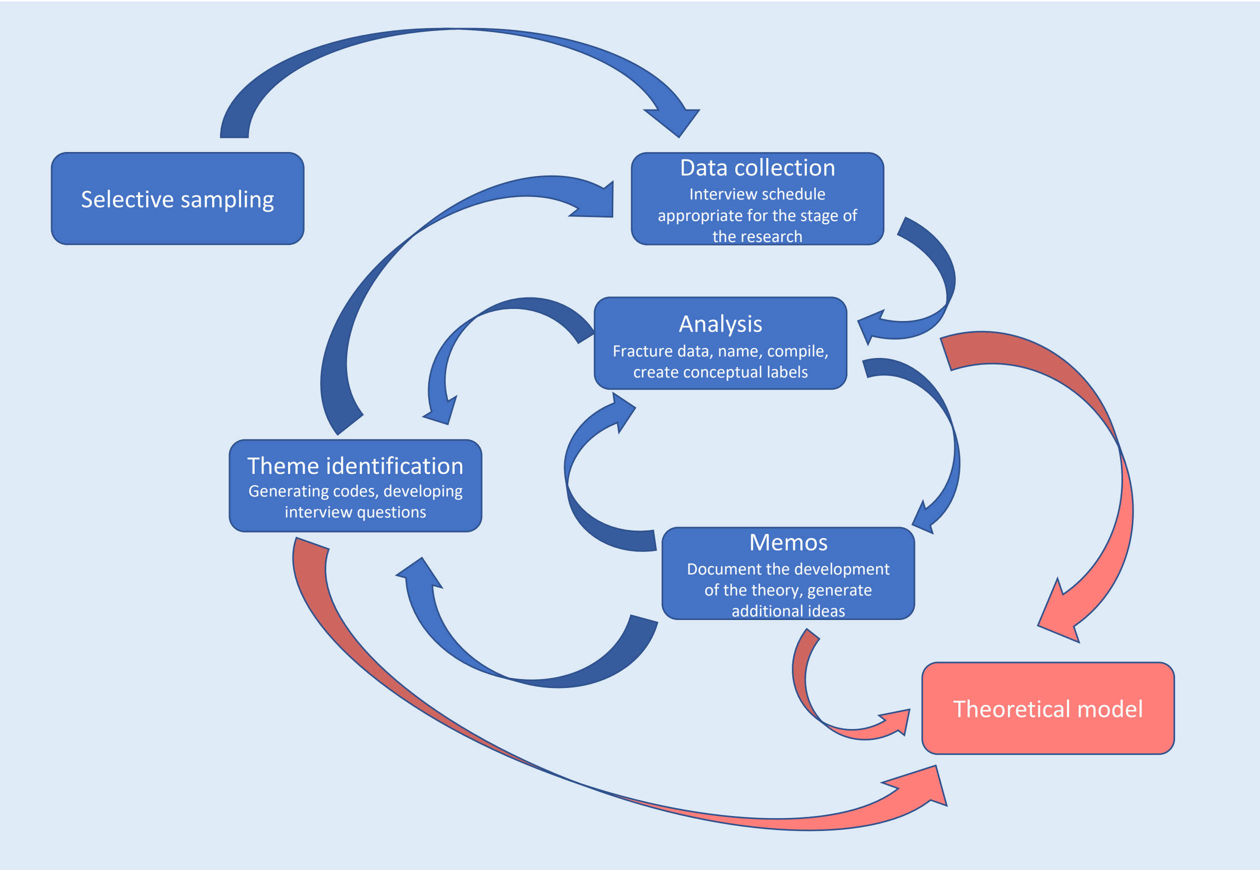
The aim of the first study was to explore the lived experience of MFD sufferers prior to, and during the onset, and gain an understanding of the psychological, psychosocial, behavioural, and environmental factors which might have contributed to the development of the condition. This inductive and phenomenological approach was chosen to gain a deep understanding of events in their careers, factors which influenced their lives, their musicianship, and the progression of the symptoms.

4. 2. Methods and materials

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 collection and examines the emerged themes to fine-tune the next level of data collection by adjusting the interview schedule accordingly. Additional ideas and memos are also documented to support the development of the model. The process is visualised in Figure 4.1.

Figure 4.1.

The process of Grounded Theory research



4. 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 4.1). 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.

Table 4.1.

Participant demographics

No.	**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

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

4. 2. 2. Data collection and 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).

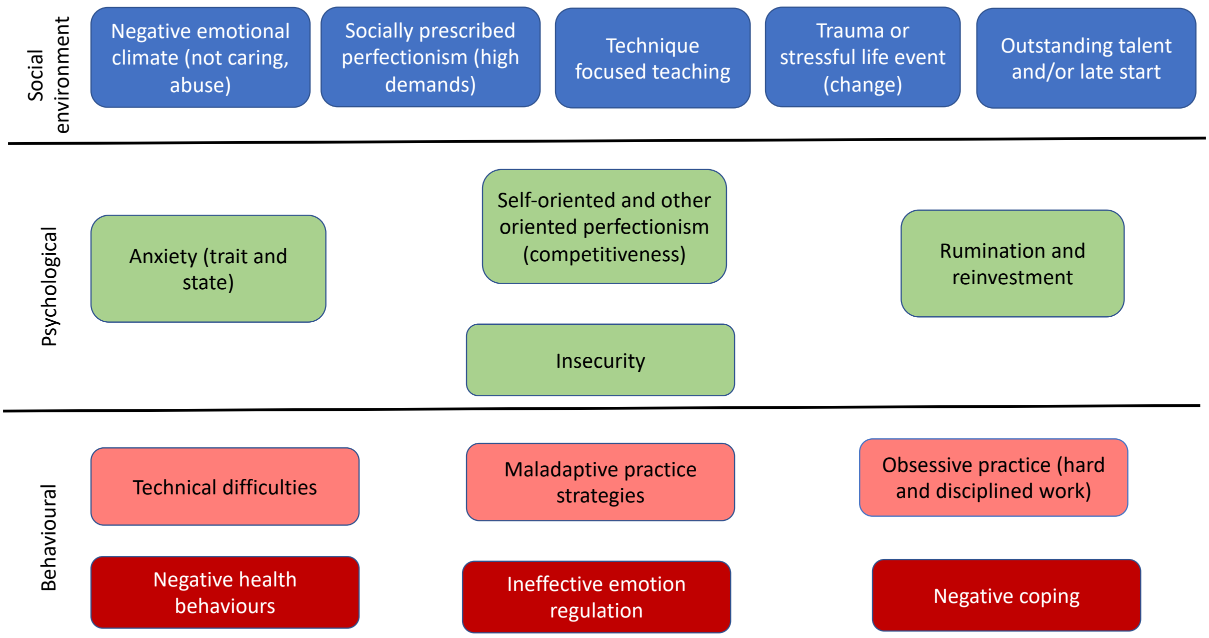
The initial interviews were open but targeted the period before and during the onset of the condition, inviting the participants to freely talk about their experiences. In this sense, they can be viewed as Life-Story Interviews (LSI), focusing on the musicianship, career, and MFD of the participants. 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.

4. 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 4.2.

Figure 4.2.

Identified risk factors of MFD



4. 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 instruments, 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.

The first theme in the category was named “negative emotional climate”. The participants reported experiencing a very strict, unforgiving, in some cases, even abusive environment, which was often accompanied by feelings of neglect. These experiences plagued their homes and their workplaces, as shown by one participant's recollection:

> When I was 13, I won third place in the national flute competition, and my mother was really abusive afterwards. She told me that I obviously wasn't talented enough to win, so I should quit and find something else to do…something I'm actually good at. At the next competition, we had a huge fight 5 minutes before I went on stage. She said that I didn't have the right attitude, I wasn't motivated enough, and that I should have come here to win. I was shaking all over during the performance as a result. (P. No. 3.)

These experiences were even more frequent in the educational environment across the sample, in which case the perpetrators were the instrumental teachers themselves. Participant No. 11. confessed that they were "just trying to survive the lessons" while others remembered their teacher's behaviour as "always screaming, always nervous, always demolishing the student" (P. No. 7). Participant No. 13. recalled the first meeting with their new conservatoire teacher in the following way:

> 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.

This was closely related to the next group of themes, labelled "socially prescribed perfectionism". When recalling their youth and music education, the participants reported that highly perfectionist tendencies were prescribed to them, as demonstrated by the recollection of participant No. 11.: “he always taught to me that if it doesn’t line up, it’s not almost correct, or good enough or nearly there, it was just labelled as wrong. Because it’s not 100%”. These demands 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. As participant No. 10. recalled: “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”. Some teachers had their entire pedagogical strategy built around various technical aspects of instrumental playing:

> He had this whole process, a whole program you had to learn. Which I guess was how you were supposed to do music. For example, he had these exact tongue placements, for every pitch almost… like, time here for that, time here for that, on that little spot. And he wrote it all in, over every note in my music. (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 (Altenmüller & Jabusch, 2006; Tubiana, 2003), 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 traumas, 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, for example, participant No. 3. described the year preceding the onset of the symptoms in the following way: “I was graduating with my DMA, organising my wedding, and applying for jobs…it was this huge mess of stress”.

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. Participant No. 13.’s narrative is an excellent example of this fast development:

> 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 in 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.

4. 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. The participants placed high, sometimes even unattainable demands on themselves and their inability to meet their goals resulted in psychological distress:

> I wanted to be able to play everything 100%, but I was only able to play to like 90-95%. And that just caused like a lot of … anguish in my head. It was like… I wanted

> to play these things perfectly, but they didn't come out perfectly, and it was hard to deal with it. (P. No. 11.)

Rumination was also prominent in the sample, some participants reported dwelling on past mistakes or creating negative predictions of the future.

> I think I have the tendency to over-play scenarios in my head that don't actually exist. […] I'll play out these scenarios in my head and get really angry. And you know, I'm sad about these scenarios that may or not transpire. And I have to make some sort of effort to get out of that. You know, sometimes it would mess up half of my day. (P. No. 6.)

In many cases, ruminative cognition manifested itself in an embodied way: participants tried to cope with their psychological distress by continuously supervising and controlling their movements when playing the instrument, as participant No. 2. describes: "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". This cognitive strategy was dubbed "reinvestment" in the model, following the terminology of sports psychology research.

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. A professional guitarist participant (No. 14.) confessed: "I always have thought about myself as a sort of fraud or something". The participants' concerns about their ability were so severe in two of them that they even quit playing for a while.

4. 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 maladaptive behaviours have also been identified in the analyses of interviews. These were divided into two main groups: playing-related and non-playing-related.

Playing-related

The playing-related behaviours were characterised by obsessive practice and maladaptive practice strategies; some participants reported playing up to 8-10 hours every day without any holidays. A pianist participant (P. No.1.) described their practice in the following way: “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”. Additionally, maladaptive practice behaviours seemed typical in the sample; the most frequently used strategies included repeating a phrase, or even a full piece, without any conscious planning.

Furthermore, many participants reported having technical difficulties which they could not “fix”, no matter how much they practised. As one participant (P. No. 3.) shared: “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”.

Non-playing-related

The non-playing-related 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. An oboist participant (No. 8.) painted a vivid picture of their frustration when they could not meet the standards they set for themselves: "sometimes I would wind up, and I would punch my book on the wire stand, across the room".

They also chose negative coping strategies to deal with their situation, most frequently lack of planning, suppression of competing activities, denial, and using substances, the last overlapping 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 and all the subsequent participants reported alcohol consumption or drug use. Some participants used substances (marihuana or alcohol) to be able to fall asleep. As one participant (No. 14) remembered: "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". Additionally, several others struggled with either insomnia or had very badly scheduled sleep patterns for various reasons. Ruminative thoughts and the inability to relax were most often identified as the cause of their insomnia, as participant No. 11. explained: "like my brain was working so hard, I couldn't even shut down by the time I was going to sleep". In other cases, the musicians scheduled short periods of time for sleep purposefully, mostly due to their eagerness to have more time to practice or work.

4. 4. Discussion

This first, exploratory study paints the picture of a multidimensional disorder with a complex web of possible triggering factors. Genetical predisposition has been shown to play a role (Schmidt et al., 2009), but this 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 the factors emerging from this study were discussed in the literature before, such as anxiety, perfectionism, and over-focusing (Altenmüller et al., 2014; Enders et al., 2011); however, listening to the personal recollections of musicians with the disorder identified new areas for further inquiry, moreover, a potential, new understanding emerged of the possible developmental 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 all 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 (Gaunt, 2011; Presland, 2005), 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 et al., 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 goals and the perceived inability to achieve them results in anxiety (Flett, Hewitt et al., 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, Madorsky 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 neurological disadvantages: the adaptability of the Central Nervous System (CNS) 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 ability 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 triggering 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 (Jansen, 2012; Juhan, 2003). It is also established that the feedback from the tutor or teacher can lead to immediate changes in motor behaviour, with positive feedback enhancing the performance (Avila et al., 2012), and there might be links between emotions and motor output in different kinds of neurological movement pathologies (Lencer et al., 2009; Ron, 2009). Furthermore, recent research shows a relationship between Adverse Childhood Experiences (ACEs) and the development of MFD (Alpheis et al., 2022); 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 et al., 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 et al., 2011; Mornell & Wulf, 2019). It has also been linked to anxiety and choking under pressure both in athletes (Iwatsuki & Wright, 2016) and musicians (Oudejans et al., 2017) and it is closely associated with certain sub-types of the “yips”, the task-specific focal dystonia of athletes (Bennett et al., 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 et al., 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 and/or internal expectations. This behavioural addiction has many documented negative effects on the physical and mental health of musicians (Lawendowski et al., 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 et al., 2015). The relationship between sleep quality and movement control in other movement pathophysiologies, such as Tourette syndrome is documented (Cohrs et al., 2001), but so far, no studies have examined it empirically in the context of MFD.

After a participant reported using marihuana to be able to fall asleep, the topic of substance abuse was added to the interview schedule. The subsequent three 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. The findings show that some of the behaviours, cognitive and emotional patterns possibly 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.

4. 4. 1. 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 et al., 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.

4. 5. Conclusion

This study contributes to a 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 (Enders et al., 2011; Ioannou et al., 2014; Jabusch &Altenmüller, 2004; Jabusch et al., 2004), 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 (Hoogendoorn et al., 2000; Kiwimaki et al., 2017) it is unwise to ignore these factors in MFD 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.

Chapter 5. Study 2.1 - The practitioner's perspective

5. 1. Aims

The second study aimed to crystallize the theoretical model which emerged from the rich, qualitative material of the first study by conducting semi-structured interviews with practitioners who have substantial experience in guiding and treating musicians with the disorder. To reach this goal, the framework of risk factors (including psychological characteristics, behaviours, and environmental elements) was presented to neurologists, physiotherapists, and musician-coaches. Moreover, the participants were asked about how they addressed the non-motor symptoms originating from the musicians' psychological states, previous experiences, and behaviours. The goal was to generate a less personal, more objective view of this vulnerable population, and explore the most common non-motor problems as contributors to the onset and as therapeutic targets. The data obtained during these interviews will be presented in the two following chapters: first, the observed characteristics of the affected musicians, followed by the employed therapeutic strategies in Chapter 6.

5. 2. Methods

5. 2. 1. Participants

For this study, the participants were purposefully chosen based on their experiences and expertise in treating musicians with MFD. Two main groups were targeted: medical professionals and researchers, and musicians who recovered from the condition and offer consultation to fellow sufferers. Information about the participants' expertise and years of experience is presented in Table 5.1.

Medical professionals and researchers were selected from authors of peer-reviewed journal articles and book chapters, based on their personal or professional interactions with

MFD patients. Recruiting medical professionals for the study raised some difficulties: some of them were simply unresponsive and some expressed their firm belief that the condition is purely neurological; therefore, did not see the point of the study. Finally, eight participants were recruited who worked with affected musicians in different ways: two participants treated them in their physiotherapy practice, three provided diagnoses and medical treatment, two conducted research, testing the outcome of therapeutical approaches and gathering data on various aspects of the condition, and one provided behavioural retraining. The participants had 9-33 years of experience, six of them were accomplished musicians themselves, and three had personal experiences with MFD.

Receiving coaching from recovered musicians is a largely undocumented option, but inquiries in several different support groups online showed that it is often favoured compared to medical options. The process of identifying participants in this group relied on different methods. Firstly, a thorough internet search was conducted, using different combinations of the following keywords: “musician’s focal dystonia”, “musician’s cramp”, “therapy”, “treatment”, and “coaching”. Members of online support groups were also asked to identify musician-coaches they have worked with, and recruited participants were asked at the end of the interviews to suggest musician-coaches they knew of, thus, the “snowballing” technique of qualitative inquiry (Noy, 2008) was also employed. Just like with medical professionals, difficulties arose with enlisting the participants in the research. Some private practitioners refused to talk about their methods in order to keep them secret and not replicable. Some felt that they would be challenged to prove that their methods work, despite the clearly communicated objectives of the research. Six musician-coaches agreed to take part, who were all former sufferers of the condition, claimed to be fully recovered, and had 6-30 years of experience.

Combined, the two groups of participants make up 14 interviewees. They have interacted with and treated over 2000 sufferers; therefore, their observations are based on a very significant pool of patients.

Table 5.1.

The participants' expertise and experience

No.	Profession	Years of experience at the time of the interview
1.	Professional musician, musician-coach	11
2.	Physiotherapist (with a background in music performance)	15
3.	Professional musician, musician-coach	30
4.	Medical doctor	28
5.	Professional musician, musician-coach	15
6.	Neurologist (with a background in music performance)	19
7.	Professional musician, musician-coach	21
8.	Physiotherapist	25
9.	Researcher, medical doctor (with a background in music performance)	10
10.	Neurologist (with a background in music performance)	33
11.	Researcher, neuroscientist (with a background in music performance)	9
12.	Neurologist (with a background in music performance)	10
13.	Professional musician, musician-coach	6
14.	Professional musician, musician-coach	18

5. 2. 2. Procedure and analysis

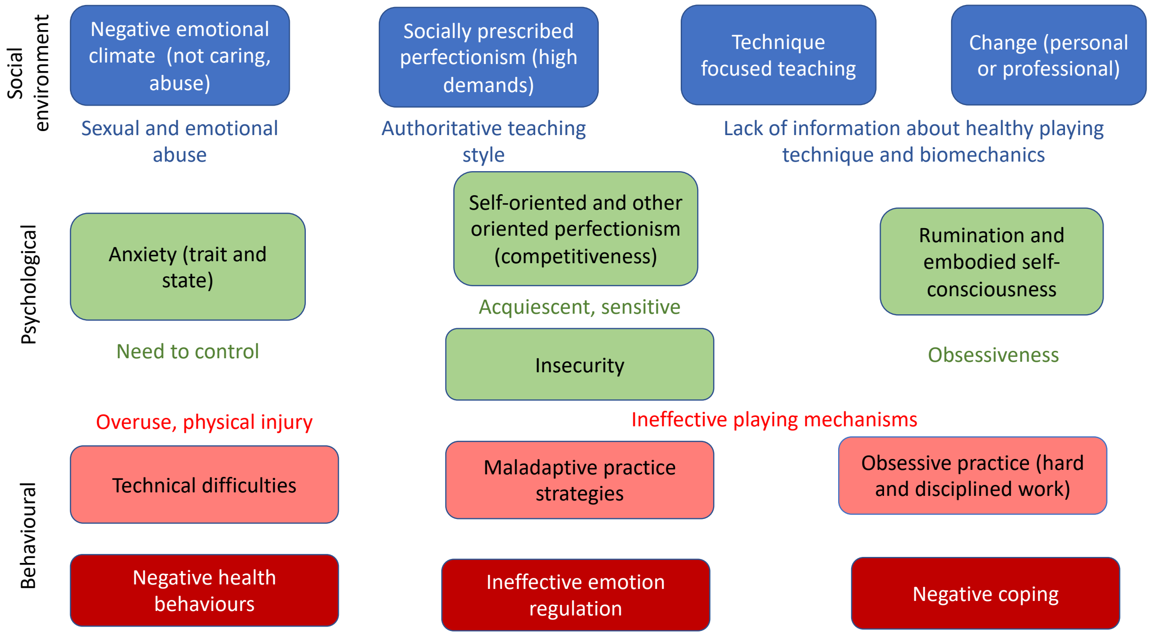
Fourteen 60-90 minutes long semi-structured interviews were conducted for the data collection. Each participant was asked about their experiences and observations of their MFD patients in terms of psychological characteristics, behaviours, socio-environmental influences, and non-motor symptoms, and how these issues were addressed in their practices. Due to the large volume of qualitative data, the treatment strategies targeting these problems will be presented in the subsequent chapter. The interview schedule (see Appendix E) was guided by the framework developed in Study 1., which gathered data from affected musicians, but the semi-structured nature of the interviews also allowed new themes to arise. The interviews were transcribed, and the data were analysed with concept-driven coding (Brinkmann & Kvale, 2018) which was deemed appropriate to use due to the already established framework. Ethical approval was granted by the Arts and Humanities Ethics Committee of the University of York and all participants were required to sign a consent form before taking part.

5. 3. Results

The three main topics of the inquiry (impact of the social environment, psychological factors, and instrument and health-related behaviours) provided a suitable framework for the analysis. Since the gathered data allowed this categorisation, the emerging themes were organised alongside the themes and topics of the original framework accordingly and are presented in Figure 5.1. In the following section, all topics will be highlighted with specific examples provided by the interviewees.

Figure 5.1.

Model of risk factors (Study 1.) complemented with the additional findings of Study 2.



Note: The themes and topics of the original framework in the squares. Newly emerged insights are presented in the space between. The colour of the text indicates the larger grouping of the themes.

5. 3. 1. Social environment

"So, these stories… if you really listen to your patients, you'll find very-very traumatising stories." (P. No. 10.)

While working with MFD patients, practitioners observed frequently repeated patterns in the patients' social environment. Firstly, many of their patients have suffered from some form of emotional, physical, in some cases, sexual abuse throughout their lives. As one participant (P. No. 10.) noted: "it can be physical trauma, injuries, but also, you know, abuse. How to say, violence…at home. Sexual abuse. In female musicians. That happens a lot". Another participant (P. No. 6.) even pointed out a possible connection between these traumatising events and movement acquisition: "this kind of stress and being used and inferior, all these kinds of terrible things, this can produce completely different movement behaviour. And can also produce constrained practice behaviour. All kinds of dysfunctional adaptations". This abuse was inflicted upon the participants' patients by their parents or caregivers, but even more often, by their instrumental teachers, as one devastating example shows: "She was repeatedly raped by her professor, who convinced her that this was the only way forward for her to be able to express music. Because she wasn't expressive enough. So, she had to have sex with him" (P. No. 3.).

The initial experiences of the sufferers in their music education were criticised and sometimes openly blamed for the development of MFD. Many participants felt that forcing the students to complete tasks that were beyond their capability, and creating a strict, unforgiving, and authoritative atmosphere were responsible for the development of the condition, or at least for the aggravation of some of the adverse psychological traits and behavioural patterns which subsequently influenced the onset of MFD:

> They don't allow them to fail, they don't allow them to take the time to study, to grow up, or anything, and then yes, I had many reports from people coming to my lessons saying: I was afraid of my teacher. And that's terrible. That's absolutely terrible. (P. No. 7.)

Apart from the psychological pressure their patients were subject to, many practitioners also criticised the content and focus of the teaching itself. The education their patients received lacked the knowledge of instrument-specific body mechanics and ignored the physical health of the students. As one participant stated: "healthy approach to piano technique versus non-healthy clearly increases the risk to develop some playing-related injuries basically and of course, also focal dystonia" (P. No. 7.). Another participant agreed, and even pointed towards a broader problem in music education:

> It’s a problem in the system of the education. So, the focus of the education is the reason. Nobody asks you how you feel. It’s okay if it’s in tune, if it’s in rhythm, or if it has a good interpretation. But how this is done in a motor way, nobody is interested in it. Nobody. (P. No. 14.)

The participants were asked about the presence of traumatic events preceding the onset of symptoms in their clients, and many were aware of their existence. However, many agreed that a singular traumatic event could not be viewed as the sole origin of the onset since these individuals were already impacted by a number of other factors. As one participant put it:

> If the person is trying to do their best, and they are in and out of balance, and something enough knocks them over. But they have been out of balance for some time and there are a number of contributing factors. (P. No. 1.)

5. 3. 2. Psychological factors

When asked to describe their patients, most participants portrayed MFD sufferers as highly perfectionist and obsessive individuals. Their need to control every aspect of their lives often resulted in rigidness and lack of mental and physical flexibility:

> They control everything. I mean they control physical things, how they work, how they move, how they feel, how they interact, they control everything. And I think that this is one of the most important…triggers or causes of dystonia. (P. No. 4.)

But there seems to be another side to this strict and stiff personality: the patients have also been described as “canaries in the coalmine”, oversensitive, acquiescent, even “people pleasers”, anxious, and ”perfectionists in a sense not wanting to make mistakes in front of others”. Moreover, the practitioners pointed out that these musicians often fear judgement which can trigger anxiety and appear to have a “fixed mindset”. Based on most of the patients’ negative experiences with their music education, they might have learned from early childhood that mistakes result in some form of punishment, and their perfectionism is a tool with which they are trying to prevent that from happening: “I have the impression that they might have been driven into dystonia because when they were very young, they had dysfunctional training behaviour which was mostly taught by their teachers” (P. No. 10).

Also, many participants – mainly the private coaches – stated that their clients were very talented musicians and “fast achievers and fast thinkers”. Only one participant disagreed with the statement saying that “the best musicians never get dystonia”. While judging talent can be a subjective matter, it is possible that non-musicians evaluate it based on achievement - which might be hindered by the aforementioned social environment and psychological factors. Musician-coaches may observe talent from a more professional viewpoint, driving their conclusions from the potential they “hear”, i.e., the quality of their clients’ skills. While this can be reported as an interesting contradiction in the data, it is impossible to tell if an aptitude, that is a hardly measurable characteristic, is present in a sample based on personal observation. However, the relationship between the impaired motor function and psychological traits was present in the minds of most participants; as an example, one neurologist stated that the “stress-induced cortisol... it can change plasticity” (P. No. 6.). Further, similar comments were made about this connection, clarifying the relationship between the psychological state and muscular function:

> The idea is that some people fight with chronic stress, they have a higher muscle tone, and this will then make the system more susceptible for dysfunctional motor programs. And this will then lead in more frequent situations into dystonia (P. No. 2).

Concluding these ideas, participant No. 10. stated: “I have a deep conviction that many of those who have non-genetically induced dystonia, have a psychologically induced dystonia; either trauma or chronic psychological anxiety disorders”. Also, the participants acknowledged the impairing effect of these factors on the therapy itself, which clearly articulates the need to address them:

> Yes, so some people, some of us musicians, are very rigid and do not like changing our ways. And you know the rigidness and determination is what made them really good and dedicated musicians in the first place. But it kind of gets in the way of the retraining. (P. No. 5.)

> Having these perfectionist minds, that might hinder the retraining because you will lose the perspective, you lose hope so easily. Because you are not getting the perfection right away. (P. No. 4.)

5. 3. 3. Behaviours

Participants were also talking about their patients’ obsessive and controlling behaviours, which they derived from their psychological characteristics, and identified these behaviours as crippling in terms of the treatment: “One crucial issue is the behaviour. In any kind of retraining…the modification of the behaviour, that’s crucial” (P. No. 6.). Moreover, these behaviours lead to over-practice which has physical consequences on the patient:

> In most cases in my statistics, I would say 80% of the people – and I would include myself in the pool - it all starts with a massive overuse. They have muscle problems, tension, short muscles for example. (P. No. 7.)

Strictly following instructions and copying their teachers or successful musicians instead of generating their own experience seems also a typical behaviour, which could lead to inefficient, uncomfortable, or even unhealthy movement.

> You know, this is how they sat by the drum set because they watched some great drummers who sat like that. And they just copied it. And they never felt, actually thought for themselves how does it feel in their body. Not someone else's instructions, or copying somebody else, but how does it feel for them. To feel that healthy function. (P. No. 3.)

In conclusion, the collected data align with the previous findings (Study 1.) apart from the aforementioned maladaptive health behaviours. Some participants were aware of problems with the sleeping schedule or quantity of sleep, but they could not provide data about other negative health behaviours, such as substance consumption, which was reported in the preceding Grounded Theory study. There might be a dual reason for this. First, the participants rarely asked their patients about their health behaviours, such as alcohol consumption. Second, in the absence of prompting, the patients were possibly unwilling to disclose such a sensitive piece of information spontaneously or voluntarily.

It is also important to mention that the quantity and quality of the information the participants provided was very much dependent on how much time they spent with their patients. Practitioners who delivered frequent treatment sessions, especially the physiotherapists and musician-coaches, had more personal contact with their patients which resulted in richer observations and conversations and were more aware of the personal issues of their clients. One participant acknowledged the fact, that in the case of medical professionals, the lack of information about the patients' personal experiences and non-motor symptoms can be the result of the lack of inquiry:

> My impression is that now it [social environmental factors] is a higher percentage than it has been 20 years ago. But this may also be due to the fact that I'm more sensitive to it. That I ask these questions and I usually ask: did you have traumatising events in your history? How did you perceive your lessons? How did you perceive the concerts? And they go: oh, yes, I have this terrible teacher and he was beating me up and so on. (P. No. 10.)

5. 4. Discussion and conclusion

The findings of this qualitative study reinforce the hypothesis that MFD is a multifaceted condition and provide an insight into experienced researchers', medical professionals', and musician-coaches' observations. It seems that the social environment, personality traits, and behaviours play a significant role in the development of MFD. Yet, the bulk of the literature is exclusively focused on certain neurological impairments and the genetic makeup of the sufferers (Lohmann et al., 2014), and suggestions for further research also follow this trajectory (Richardson et al., 2017). The reluctance to examine psychological, social, environmental, and behavioural factors is possibly due to previous research where TSFD was oversimplified as a type of hysteria, primarily a psychiatric disorder (Munts & Koehler, 2010). These views were highly criticised with the advancement of brain imaging technology, and as a result, psychological and psychosocial factors were generally neglected in subsequent research (Munts & Koehler, 2010). The emerged neurological model originates the onset of the condition from the degradation of the cortical representations of the affected body part (Byl, 2006; Byl, 2007), impaired inhibitory processes and sensory perception (Altenmüller & Jabusch, 2010), and heredity factors (Lohmann et al., 2014; Schmidt et al., 2009). While this model provides valuable insight to supplement the current understanding of the neural processes and familial components related to MFD, the triggering factors, the susceptibility, the severity of the movement impairment, the progression of the dystonia, and the primary pathophysiology are still not well understood (Altenmüller & Jabusch, 2010).

To find the answers to these important questions, examining the presented contributing factors, such as the psychopathology of the sufferers, might be crucial. The findings align with previous Grounded Theory study and the literature in terms of heightened levels of anxiety and perfectionism (Enders et al., 2011; Jabusch & Altenmüller, 2004; Jabusch et al., 2004) but elaborated on them by adding comprehensive details and refining the patient profile. Many of the practitioners also hypothesised links between these traits and the motor symptoms, and many of these ideas are reinforced by the literature.

There is growing evidence on how psychiatric and neurological conditions are intertwined. Research into disorders that are classified as psychological shows that there are structural changes in the brains of the sufferers (Schmidt et al., 2009), and similar circuits might be responsible for motor function and psychiatric deficiencies (Ron, 2009). Some researchers even called for the merger of the fields of neurology and psychiatry, given both are concerned with disorders of the nervous system and claim that the strict distinction between them is "counterproductive for clinicians and patients on both sides of the line" (White et al., 2012, p. 26). Therefore, it is important to rethink our approach to MFD, especially in light of the described psychological problems in MFD patients because these issues might not only play a greater role in the onset than previously thought but also might be an important part of treatment. The traumatic impact of losing one's playing skill has psychological, physical, and financial implications and can possibly aggravate pre-existing psychological problems even further, leaving the musician in a vulnerable state.

Preceding traumatic experiences, both in a developmental stage and in adulthood, were not considered as the sole origin of the onset of MFD by the participants; however, they were identified as possible triggering factors. Findings showing that childhood trauma stemming from mistreatment (Woon & Hedges, 2008) and higher exposure to life trauma (Seo et al., 2019) can lead to changes in neural structures and responses seem to support these views. Moreover, more recently, a link has been identified between emotional neglect in childhood and MFD (Alpheis et al., 2022). While the neurological and psychological processes underpinning this association are yet unclear, these preliminary results suggest that traumatic life experiences might indeed play a role in the onset of the condition.

Another interesting finding from this study was that sufferers seemed to receive a low quality of teaching in terms of body mechanics and efficient movement patterns when playing the instrument. This suggests that the motor pattern which deteriorated later, might have been inefficient in the first place, and exacerbated due to excessive, repetitive practice. Since the current dystonia model and the theories about inhibition and structural changes in the brain are unable to explain why only an individual task is affected (Sadnicka et al., 2018; Stein et al., 2016), examining the motor pattern, its quality and how it was acquired might provide further clues for explaining the onset of the disorder. Sadnicka et al. (2018) theorised that the symptoms are not the result of a disordered neural process, but compensatory movements of an otherwise healthy motor system. The reason for this compensation might stem from straining, unhealthy movement patterns, which would also explain the co-morbid performance-related overuse, reported by some of the participants. In conclusion, the music education the sufferers received determined their movement patterns when playing their instrument, and subsequently, might have influenced the onset of MFD.

While the present study highlighted the possible role of additional factors stemming from the social environment and the individual musician's psychological traits and behaviours in MFD onset, it has certain limitations. Although the findings presented are based on reports of the observations of a large number of sufferers, the data mirrors the participants' subjective opinions. Qualitative inquiry, by its nature, cannot be fully objective. In this case, this bias was potentially furthered by the personal experiences of the nine participants who were affected by the condition themselves at one point in their careers. Nevertheless, their observations and experiences, furthermore, the large in-direct sample size and the agreement on the majority of the topics significantly strengthen the findings of this study.

In conclusion, more information is needed about the psychosocial, environmental, and behavioural characteristics of musicians with MFD to enhance prevention and treatment. This qualitative research study suggests that these aspects might be equally important as the neurological and genetic factors, and they are worthy of consideration both as triggering factors and therapeutic targets in MFD. Broadening the scope of inquiry and involving the expertise of patients, music educators, and psychotherapists to complement the work of neurologists and rehabilitation therapists could lead to a more detailed, holistic understanding of the aetiology, as well as the management of MFD.

Chapter 6. Study 2.2 - Insights about holistic treatment approaches

6. 1. Aims

The data collection aimed to explore how non-motor (i.e., psychological and behavioural) MFD symptoms are addressed in ongoing practices. The data presented here was collected from the same participants as the preceding study (see Chapter 5.), but due to the volume of the rich qualitative data, and the distinct topic of the inquiry, the analysis and results are presented separately in this chapter.

6. 2. Methods

6. 2. 1. Participants

The research participants for this study were the same as the participants of Study 2.1. For detailed information, see Chapter 5., Section 5.2.1. and in Table 5.1.

6. 2. 2. Procedure and analysis

The data collection for this study was conducted in the same session as the previous one (Chapter 5.); therefore, the procedure of the data collection and ethical considerations will not be repeated here. A detailed description of the process is presented in Chapter 5., Section 5.2.2.

The analysis of the data connecting to the topic of rehabilitation strategies, however, was data-driven, given that there were no previously established frameworks or concepts regarding the strategies employed to support the non-motor symptoms of musicians with MFD. Following the recommendations of Brinkmann & Kvale (2018) the process started with systematically identifying similarities within and across the cases, then establishing the main concepts, and arranging the topics into larger groups of themes to provide a clear summary of the content of the interviews.

6. 3. Results

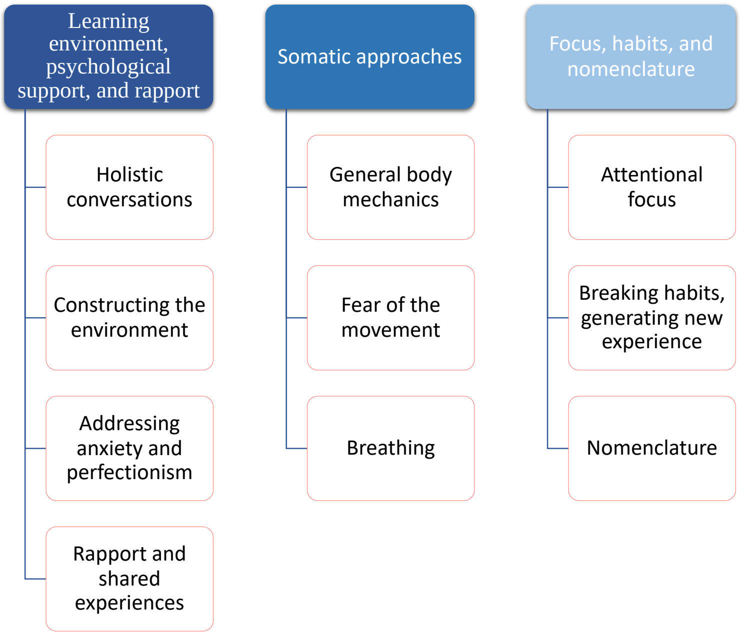
The participants' practices differed greatly in terms of the quantity and frequency of the time spent with their patients and clients. Due to the nature of the administered therapy, musician-coaches, physiotherapists, and practitioners delivering behavioural interventions met with the musicians periodically, typically for sessions spanning from 30 minutes to two hours. Neurologists, following the initial consultation and the prescription of the treatment, had less contact with their patients, similarly to the two researchers in the sample, who worked with their musician participants for designated periods allocated for data collection. Naturally, these differences expressed themselves in the quantity and quality of information the participants could provide on the topic: those who were in more frequent contact presented a wider variety of strategies to support the affected musicians.

As the findings of Study 1. and Study 2.1 show, musicians who are affected by MFD and enter a rehabilitation program, potentially have multiple problems apart from the physical symptoms of the disorder. Some of these stems from previous traumatic experiences, some can be linked to psychological characteristics, and some are established unhealthy behaviours. These pre-existing issues are potentially aggravated by the traumatic experience of the onset, moreover, the inability to play to the accustomed level can result in financial insecurity, identity crisis, fear of the future, and for some, depression. This situation creates feelings of anger, guilt, victim identity, and lowers the musicians' self-efficacy and self-esteem, and possibly disrupts the social network of the individual. All participants agreed that this vulnerable and complex situation can greatly influence the outcome of the rehabilitation program, and they shared various strategies which they use to address them.

The findings were grouped into three categories which will be presented in the following order: 1. Learning environment, psychological support, and rapport 2. Somatic approaches 3. Focus, habits, and nomenclature. The summary of the findings is shown in Figure 6.1.

Figure 6.1.

Strategies for addressing non-motor symptoms



6. 3. 1. Learning environment, psychological support, and rapport

Holistic conversations

In most practices, including the patient's experiences, feelings, and behaviours in the initial discussion is viewed as an important step. The goal of this consultation is to gather information about the specific case, but also, to make the client feel heard, understood, and accepted. Actively building rapport and finding a connection are tools frequently used by many participants; as participant No. 6. articulated: "the crucial thing is to understand the situation of the patient. The entire situation. Not only see his finger, or which finger moves in which direction". This caring and compassionate therapeutic relationship can create a better atmosphere but also has a direct influence on the learning process of the musician: “I’m always interested in finding the right access to the person, also psychologically, so maybe they can listen more correctly to what I’m saying” (P. No. 5). One participant (P. No. 3.) even uses systematic data collection which is continuously updated when they gain new insight.

> So, I have people self-report: are they right-handed or left-handed, how well can they focus their attention, how susceptible are they to depression? How self-critical are they? So, they answer a questionnaire. […] And I walk through some of that in the initial consultation as well. And I want to know if I'm coaching anybody […] are you an endurance athlete or are you a sprinter? Do you focus better in the morning? What is your schedule? What is your support system like? All of that.

These conversations also form a substantial part of the following treatment sessions to support the rehabilitation. As one practitioner (P. No. 6.) described this process:

> It definitely belongs to the retraining procedure, to listen to the people and discuss… sometimes half of the session is discussion…and we go to the piano afterwards, and sometimes they feel also that they need to talk… I don’t know if I have some sort of psychologist role, but I sit down and listen. Basically, what they have to tell me. And then after, we can work correctly. But if I skip that, I think that wouldn’t be suitable for the efficiency of what we’re doing at the instrument.

Constructing the environment

Behavioural therapies are in many ways similar to traditional instrumental lessons. They are repeated frequently, exercises are given that the client/patient needs to practice, and which are monitored and evaluated in the subsequent lesson to determine the improvement. This similarity seems to evoke the participants' original behavioural patterns: they want to please, they are afraid to make mistakes, and in some cases, they are even ashamed of their symptoms. As a musician-coach (P. No. 3.) explains: "When I first start to work with a client, I would get them to do an exercise and they don't want to, because if it's not perfect, they just stop."

Many participants felt that changing this atmosphere was crucial for working with the patient efficiently and they defined "safety" as the most important characteristic of the learning environment. Creating such an environment happens both verbally and behaviourally; the musicians are assured that there are no expectations towards them and are treated with understanding and patience:

> I'm extremely committed to the fact that I have absolutely no single expectation when they are showing up. And that's a thing which I keep telling them again and again. We sit down, and we have a look at the hand. And there are no obligations. And I think it is very-very important. (P. No. 7.)

Addressing anxiety and perfectionism

When dealing with the psychological distress and negative emotions of their clients, participants use a rich variety of tools. Two participants were trained in psychotherapy and use their knowledge to help the musicians right after their diagnosis: "Usually I do this kind of short intervention. Psychotherapy intervention indeed" (P. No. 10).

Others studied body-oriented techniques, such as Alexander Technique or Dispokinesis[14], and since these approaches have strong cognitive elements, they prove to be

[14] Dispokinesis is a form of movement training and therapy, developed specifically for musicians and stage artists by Gerrit Onne van de Klashorst at the University of Amsterdam.

appropriate tools to reach an ideal mindset in the patients. Some mentioned using Neuro-Linguistic Programming (NLP) or other frameworks, while musician-coaches primarily rely on their own experience and share the information which they found helpful in their own rehabilitation and in their practice. Each of these interventions is tailored to the specific case within the chosen modality.

Dealing with the musicians' anxiety is one of the main objectives of different treatment strategies. As previous research has shown (Ioannou et al., 2014), not all patients are suffering from clinical anxiety disorders, but given their situation, all affected musicians seem to have anxieties around their playing and rehabilitation. The importance of reducing anxiety was stressed by participant No. 6.: "it [anxiety] will modify the way they act, the way they do certain things, the attention they will put to the therapy, so it is absolutely important to reduce or solve that". Also, understanding the source of the anxiety by asking the patients specific questions is often the first step towards supporting the musicians and helping the practitioners to create new strategies.

> That anxiety is from: "I don't know what to do, I don't know how to do it, I'm lost." And so, again, rather than looking at the anxiety […] I always prefer to look at the solutions. Why is that anxiety there, what is this person anxious about? What is going on in their lives? (P. No. 3.)

In serious cases, external treatment is suggested with a psychotherapist, but most practitioners aim to reduce their patients' anxiety during the sessions by creating an accepting and open learning environment.

Perfectionism and the “need to control” were the next traits identified by the practitioners as harmful for the rehabilitation, and to address it, most often reappraisal is suggested. One participant uses the following mantra to further this process*:* “I control the fact that I don’t control” (P. No. 7). Others provided anecdotes of famous musicians making mistakes or dismantling the idea of perfection by providing a new framework with music as communication in the centre, instead of avoiding making mistakes. Participant No. 3. uses the expression “paint by numbers” to describe the desperate need to play every note flawlessly without considering the artistic content and explains it in the following way:

> People assume that if you put all these notes in this right order, in the right way, it is going to out to be some work of art. But no matter how perfectly you place those notes, it will never turn out as a piece of art. Not without communicating something with it.

This approach is also aimed to reduce the anxiety around making mistakes and helps the client to refocus their efforts on their expressivity.

Rapport, shared personal experiences

In addition, all musician-coaches mentioned the importance of their personal story: sharing their own experience with the disorder builds trust in the musicians with MFD and gives hope that they can also overcome the condition. As one musician-coach articulated it:

> I strongly believe that the fact that I got myself focal dystonia is an extremely strong point to them. As well as to me. So, they know I know. They know I can understand.

They know that I can feel what they feel, not only physically, but also psychologically. Because I’ve been through it too. (P. No. 7.)

6. 3. 2. Somatic approaches

General body mechanics

Most practitioners agree that the problem is usually more widespread physically than the dystonic limb or facial muscles. Musicians with MFD generally carry a lot of muscular tension in their bodies and have inefficient postures both when playing and in everyday life, which – in the practitioners’ opinion – should be a therapeutic target in all practises. As participant No. 3. articulated this: “It's global before it's specific. And that, I believe, is one of the biggest mistakes that educators make, that clinicians make, especially because of this specialization, that we all make.” These deficiencies are often undetectable for the musician with the disorder due to its habitual nature: “Some of my clients had never felt release. They have been walking around with so much tension for so long, that their body has learnt this, you know?” (P. No. 8).

To relieve these tensions from the entire body and reach a balanced and healthy alignment is one of the most important elements in many practices. Some use different body-oriented techniques, such as the Feldenkrais Method, Alexander Technique, or Dispokinesis in their practices to gain “healthy function” and a “global sense of release” (P. No. 13.) before they move on to the exercises targeting fine motor control.

Fear of the movement

The affected musician’s relationship to the instrument also needs to be addressed: the fear of the symptom and its unpredictable nature leaves many affected musicians feeling helpless or agitated which has a significant impact on how they approach the instrument and complete the prescribed exercises. Participants linked this fear to previously suffered traumas in connection to the instrument:

> ...when you first touch the instrument again, then this trauma situation comes back. When they open the case, everything reminds them of the situations they have experienced. That takes a long time to overcome. The fear of touching the instrument. (P. No. 14.)

To aid the process of overcoming the fear, practitioners also use sequential exercises, starting with very simple movements, and making each step attainable: “Every exercise is sequential […] And it is based upon successfully making a match between task and skill. And that builds a sense of self-esteem” (P. No. 3). Also, there is often a cognitive element added in the form of positive self-talk, which is continuously reinforced and repeated throughout the session:

> It’s like a little devil sitting on your shoulder [the fear and anxiety], and it is talking into your ear. And if you recognise: oh, hello, it’s you, there you are (makes plucking noise, imitates flicking something away). You’re not necessary! (P. No. 14.)

Breathing

Some practitioners also observe and correct the breathing patterns in their practices, not exclusively with embouchure dystonia patients. Breathing exercises are used to re-establish healthy breathing function, which is often agitated due to the anxiety and fear of approaching the instrument and can further implications to the motor function as well:

> So, someone has a hand dystonia, and their hand is reacting, but I see them going like this (breaths in hyperventilation), I'm not going to talk about their hand. Because if I'm chronically hyperventilating, one of the symptoms is spasm. So, my hyperventilation might be leading to that tension. (P. No. 1).

The holistic approach also distracts the patients' obsessive focus on the motor symptoms and leads to a broader sense of their body mechanics, i.e., embodiment. This cognitive element of the therapy can also be understood as a form of mindfulness and has additional benefits in reducing anxiety.

6. 3. 3. Focus, habits, nomenclature

Attentional focus

All practitioners agreed that consciously directing the focus of attention is one of the most important elements of retraining; however, their opinions differed about the optimal direction of this focus. Some practitioners subscribed to the idea of encouraging external focus, due to its superiority to internal focus when performing already learned movements (Wulf, 2013). Channelling the focus of attention away from the affected body part can improve the motor symptoms but it is also aimed at reducing the fear of failure and the excessive need for control:

> The most important is to solve this need for control in the patient […] when we are doing the neuro-rehabilitation exercises, we combine them with second activities. So, at the same time when the patient is doing a specific exercise on the instrument, we ask him to solve mathematical problems, coordinative exercises, games on the iPads et cetera. It is one of our strategies. (P. No. 4.)

However, others stated the opposite and prescribe increased focus on the affected body part and its motor movements in their practices and believe that it significantly furthers the rehabilitation: “I think the people who recovered fairly fast, they have trained themselves to be hyper-aware of what they're doing and how” (P. No.1). Among others, participant No. 6. felt that both types of attentional foci have value in terms of the rehabilitation:

> Of course, the external focus is highly important. But I think we also need, as an additional tool, this internal focus, where we 100% focus on the forces, on the movements, like we just crawl into the hand, we are 100% in the hand, in order to go on, and step by step improve playing technique.

Also, as participant No. 10. pointed it out, the employment of different types must be carefully balanced depending on the situation: “internal focus when you’re working on your tensions, and external focus when you’re performing, this has to be taught. I think that’s important”.

Breaking habits, generating new experience

Interestingly, both types of instructions are aimed at “breaking the habit” of how the instrument is approached: “I try to break the habit of their approach first, because whatever way they are used to approaching their instruments is kind of contaminated with dystonia” (P. No. 1). Moreover, many practitioners stated that emotions and the way the musicians express themselves through music are connected to the symptom; therefore, they actively dissect their clients’ motor movements from their musicality at the beginning of the retraining:

> When you want to play in a very special way, you think that your emotions should feel very intense. And you increase and increase the tension, and you don't know what you are doing is not necessary. I measured this for example with cellists – if they play in the high positions, they use the weight of the hand, and the fingertip gets up to 4kg on the string. (P. No. 14.)

> And for most of my clients, I take the musicianship, and I put it on the shelf. And protect it. And I say: right now, your auditory signal has been connected to an abhorrent motor signal. So, what we have to do is just protect that for a bit, and we are just going to retrain healthy motion. And incrementally, so each step is successful. (P. No. 3.)

Building a new set of habits and re-learning certain movements is the core element of every retraining strategy, and it relies on the active participation of the musicians not only during but also between the sessions. Therefore, instead of following instructions, the musicians need to develop a sense of embodied and mental self-awareness to be able to observe their technique and practice, even when they are not under the direct supervision of the therapist. One successful strategy to achieve this is "provoking experience" and creating a space where musicians can exercise agency rather than prescribe an "ideal movement" they need to achieve. As participant No. 14. articulated: "I never say it is wrong or right. I always give the possibility to choose to the people. They can decide for themselves. I give them a situation where they can choose".

The whole process of rehabilitation can last for years – it is a long and difficult process for most. To maintain the sense of being a musician, most patients are advised to restart performing in low-pressure situations with a carefully chosen literature as soon as possible. Some practitioners encourage them to discover and play within the limits of their ability, using improvisation.

Nomenclature

To enhance the process of rebuilding one's instrumental technique, the nomenclature is also important; the affected musicians should not feel judged and have to keep an open mind to explore new possibilities in terms of movement, practice behaviour, and instrumental technique. Participant No. 13. stressed that the words used to instruct the musicians make a "big difference", especially when it comes to evaluating a motor movement; here, the focus needs to be on functionality and efficiency rather than meeting prescribed standards: "why would I think, that there is a right and a wrong way, versus an efficient way or structurally functional way? So, our nomenclature makes a big difference".

6. 4. Discussion

Rehabilitation from MFD is a very complex process, and to reach the primary goal – to eliminate the involuntary movements and regain complete motor control when playing the instrument – practitioners use a wide variety of tools which influence cognition, emotions, and psychological states apart from working on the physical symptom. In some cases, these tools are clearly directed towards the patients' mindset, but most often, they are intertwined with the exercises aimed at improving the affected motor movements. Many of the presented strategies have a motor and cognitive-emotional content at the same time; therefore, the grouping of these strategies is somewhat artificial. Nevertheless, the established framework provides a sense of structure that can be used as a precedent.

The first group of presented tools are all aiming to establish a safe and calm atmosphere, in which the musician can work more efficiently. Given the frequently reported adverse experiences in the professional environment and the trauma of the onset itself, it is unsurprising that many affected musicians enter this learning space in an agitated and distressed state. This can have further implications for movement acquisition and performance during the rehabilitation: as Juhan (2003) explains, “the feeling states that are being experienced at the same time learning is taking place are recorded along with the performance or the information, and closely associated with future recall” (p. 372). From a neuroscientific viewpoint, the possibility that movement recall and performance are influenced by emotional states is also acknowledged. Ron (2009) argues that similar circuits can be involved in movement and emotions, and the neural activity taking place can “elicit or suppress motor activity in response to emotion” (p. 1059). Therefore, previous negative experiences might have a direct impact on how the movement is executed, and at the same time, can have further implications for the psychological state of the musician. Extrapolating from this, viewing the patients’ emotions and psychological states stemming from these experiences as therapeutic targets is hugely important because they might have a significant impact on the outcome of the treatment.

The biomechanics of instrumental technique is one of the obvious targets of the rehabilitation; however, the participants highlighted the importance of thinking about movement in a broader and more holistic way. Firstly, many of them emphasised that apart from the affected fine motor skills, the overall body mechanics and posture also need careful attention. This aligns with several documented treatment approaches, for example, both Tubiana (2003) and Ackermann & Altenmüller (2021) stressed the importance of including larger structures (e.g., torso, scapula, spine) in the rehabilitation, while other documented rehabilitation protocols use general fitness exercises as part of the treatment (Byl et al., 2009).

Attending to the movement behaviour not just on a mechanical level but taking the musicians' previous experiences into account must also be stressed: the rehabilitation of the motor function is inseparable from the reappraisal of the accompanying emotions. Many participants acknowledged that fear and unconscious avoidance appear in the affected musicians when they attempt any performance-related movements. Benett et al. (2015) observed similar tendencies in athletes experiencing the "yips" and Lost Movement Syndrome (LMS) as they highlighted the "feelings of fear associated with the affected movement pattern, both in relation to the consequence of experiencing movement breakdown, and to avoidance of executing affected moves" (p. 65). The most frequently used therapeutic response to this fear in the sample was to start with very simple and attainable movements and gradually increase the difficulty, while carefully monitoring the musicians' physical and emotional responses.

It also needs to be mentioned that musician-coaches also attended to the biomechanical quality of the fine motor movements associated with playing the instrument. Opposing the general but unexamined notion is that before the onset, the movement patterns of the affected musicians were optimal, the musician-coaches agreed that many of their clients had ineffective and unhealthy technique even before the onset. Data obtained from affected musicians in the Grounded Theory study show similar tendencies: many of the participants in the sample struggled with certain technical aspects of their playing, often for years before the onset, sometimes even through their entire career. Even more interestingly, those who shared these experiences reported that their first symptoms appeared when attempting to perfect said skill. A similar tendency was found in Lost Movement Syndrome: Day et al. (2006), when interviewing elite trampolinists affected by this task-specific movement disorder, traced the onset back to shortcomings in the initial movement acquisition. This characteristic of the instrumental technique preceding the onset signals that during the retraining, instead of rehabilitating the old movement patterns, some adjustments and corrections need to be made. Therefore, even if the therapy is not led by a musician-coach, the support of a music educator might be necessary (Tubiana, 2003).

The idea of inefficient playing technique as an origin is also supported by Sadnicka et al. (2018). According to their recently suggested framework, the symptoms are compensatory movements of an otherwise healthy motor system rather than unexplained reactions of an incapacitated neural network (Sadnicka et al., 2108). In other words, the employment of a suboptimal movement pattern can lead to a misalignment between the increasing requirements of the musical tasks as the career of the musician advances and their ability to meet them.

Practitioners also acknowledged the fact that the way patients think, focus, and direct their movements cognitively can create significant changes in the quality of the motor output. Some of the participants arrived at this conclusion intuitively or deduced it from their personal experience, but it is also supported by the literature. As an example, it has been shown in the field of sports psychology that modifying the attentional focus can lead to changes in muscle tone, consistency, accuracy, endurance, and even the degrees of freedom in joints (for comprehensive reviews, see Wulf, 2013 and Wulf & Lewthwaite, 2016). Sadnicka et al. (2018) make a similar point, specifically about task-specific dystonias: “the influence that misdirected cognitive influences can have on skill performance is worth emphasizing” (p. 123).

Instructing musicians to direct their attentional focus differently can be easily achieved; however, there were differing opinions about the optimal focus point among the participants. While sports psychology literature firmly established the superiority of external focus when acquiring or performing various skills (Wulf & Lewthwaite, 2016), the majority of the studies explored the role of attentional focus in the movement of healthy individuals (Wulf, 2013). Apart from the qualitative data obtained by this study, there is no literature available on the role of attentional focus in the rehabilitation of MFD. The topic, however, is worthy of attention and further, detailed exploration.

Until recently, the diagnosis and treatment of MFD were exclusively the tasks of neurologists. However, this newly emerging framework of understanding MFD, which includes non-motor symptoms and possibly, very specific technical issues of instrumental playing, requires music educators and musicians to participate in the process. As seen in this study, some musician-coaches specialise in providing therapeutic instrumental sessions; however, music educators can also help to develop and provide preventative educational tools.

The evidence (presented in Studies 1. and 2.1) of the link between the quality of educational experiences and the onset of MFD can be used to inform preventative strategies. Based on the findings, the three main pillars can be outlined: 1. creating an accepting and safe working environment for the student, 2. being informed about the biomechanics of the technique and actively monitoring if the student is playing in an efficient and healthy way 3. withstand the pressure from the music industry which promotes, encourages, and celebrates "perfect" and hugely demanding performances, often at a very young age, by using prodigies as role models. The last point is hugely important for developing a stable and well-supported technique, giving the students authority over their own learning, and avoiding psychological pressure. The main goal should be to support the development of a healthy technique which requires strong foundations. As one of the participants put it: "Young children need the best teachers" (P. No. 10).

Music educators are also ideally positioned to detect the first signs of movement deterioration. While the onset of the condition typically happens in the 4th decade of the playing career, in study samples, participants as young as 17 are not rare (Conti et al., 2008). In cases where the developed technical issues in a young musician appear unsolvable by educational means, with a basic awareness and understanding of the condition, music teachers can direct their students towards appropriate support. With this approach, affected musicians can receive help at the earliest signs of deterioration, which gives them a better chance to recover. Therefore, raising awareness among music educators could be a helpful tool to support recovery.

When it comes to treatment, especially behavioural therapies, the role of music educators can be even greater. Since they have in-depth knowledge of the instrumental technique, i.e., the motor patterns which need to be recovered, their expertise is crucial in developing the appropriate retraining programs and practice schedules. They also have personal experiences of the schedule, lifestyle, unique external influences, and stressors and pressures which are part of the profession; therefore, they can approach the affected musicians in a compassionate and understanding manner. The knowledge of musicians who themselves recovered from the condition is especially invaluable. More research is needed to explore the tools they used in their own rehabilitation and their approach when treating clients to support their recovery.

6. 5. Conclusion

MFD is a multifaceted condition with a wide range of non-motor symptoms, which originate from personality traits, socio-environmental factors, and learned behaviours. Practitioners are not only aware of this largely undocumented field, but they also developed certain strategies to address it. As the data shows, there is a wide variety of tools they employ, but we know very little about their efficiency. The literature assessing behavioural therapies for the condition exclusively discusses the treatment of the physical symptoms, even though the influence of various psychological and behavioural factors appears to be significant.

There are many ongoing successful practices led by former sufferers, somatic practitioners, and medical professionals, with decades of experience which have never been researched or assessed; thus, the accumulated knowledge of these individuals remains largely unexploited and benefits only the clients they directly work with. More research is necessary to understand the protocols of these practices, especially the tools they use to meet the psychological and behavioural needs of the musicians with MFD. In order to enhance MFD treatment, it is necessary to establish communications between practitioners from various backgrounds and experiences; as one musician-coaches put it (No. 3.): “this needs to be a collaborative effort between us, psychologists, physiologists, the neurologists, the actual musicians, and music educators”. The result of this collaboration should be a clear consensus on how the condition should be addressed and how the therapy can be aided by psychological and behavioural tools.

Chapter 7. Study 3. - Hypothesis-testing study

7. 1. Aims

The aim of the final study in this thesis is to explore the frequency of the risk factors presented in Study 1. and Study 2., by comparing musicians with and without MFD. The goal was to identify the most common problems in this vulnerable population to support the development of targeted treatment and preventative strategies.

7. 2. Methods and materials

7. 2. 1. Design, setting, and participants

This hypothesis-testing questionnaire study is the final stage of the larger mixed-method study presented in this thesis. The previously conducted interview studies with MDF sufferers and practitioners which retrospectively explored the personal experiences of musicians with MFD prior to the onset served as a basis for the present survey study. The topics were selected from this rich qualitative material and aimed to cover themes that were strongly supported by both interview studies and were unexplored by previous literature and an attempt was made to link this content to formerly established concepts and use validated scales when available.

The questionnaire was administered online, and apart from identifying as a musician with or without MFD, there were no exclusion criteria. Participants were recruited from online support groups and social media platforms, and various organisations and practitioners were asked to share the information and the links in their networks. A total of 240 musicians (125 with MFD and 115 healthy) answered the survey. After omitting unfinished and partial responses, 175 cases were considered for further analysis. To allow for a more precise comparison, a pairwise matching between participants with and without MFD was conducted based on gender, age, and instrument group, which resulted in a subset of 88 musicians.

Information about the mean age, gender ratio and instruments played in the sample and the subset is presented in Tables 7.1. and 7.2.

7. 2. 2. Study variables

Sociodemographic information was collected (age, gender, instrument played, level of education, and profession), and questions were administered about the participants' experience with the received music education, performance-related mistake rumination, lifetime prevalence of trauma, and other stress-inducing experiences. Additionally, questions were added to inquire about the location of the symptoms of MFD and the received diagnosis in the MFD group.

Table 7.1.

Age and gender characteristics of the samples

Group	Age	Gender distribution			
	M (SD)	Female	Male	Non-binary	Prefer not to say
Full sample (N= 175)	42.5 (14.3)	79 45.1%	93 53.1%	1 0.5%	2 1.1%
Full MFD sample (N= 105)	44.4 (14.2)	40 38%	63 60%	0 -	2 1.9%
Full healthy sample (N=70)	39.5 (13.9)	39 55.7%	30 42.8%	1 1.4%	0 -
Selected subset (N=88)	42.3 (13.5)	46 52.2%	42 47.7%	0 -	0 -
Selected MFD cases (N=44)	42.5 (13.6)	23 52.2%	21 47.7%	0 -	0 -
Selected healthy cases (N=44)	42.1 (13.6)	23 52.2%	21 47.7%	0 -	0 -

Note. The standard deviation is presented after the means in parentheses. The percentages are calculated in relation to the group size which is presented in the first column. MFD = Musician's Focal Dystonia

Table 7.2.

Instrument distribution of the samples

Group	Instrument distribution					
	Wind	Brass	Strings	Percussion	Piano	Plucked
Full sample (N= 175)	42 24%	44 25.1%	20 11.4%	8 4.5%	33 18.8%	28 16%
Full MFD sample (N= 105)	22 20.9% (8 – 7.6% with ED)	30 28.5% (25 – 23.8% with ED)	8 7.6%	6 5.7%	17 16.1%	22 20.9%
Full healthy sample (N=70)	20 28.5%	14 20%	12 17.1%	2 2.8%	16 22.8%	6 8.5%
Selected subset (N=88)	26 29.5%	18 20.4%	18 20.4%	4 4.5%	12 13.6%	10 11.3%
Selected MFD cases (N=44)	13 29.5% (3 - 6.8% with ED)	9 20.4% (9 – 20.4% with ED)	9 20.4%	2 20.4%	6 13.6%	5 11.3%
Selected healthy cases (N=44)	13 29.5%	9 20.4%	9 20.4%	2 20.4%	6 13.6%	5 11.3%

Note. MFD = Musician's Focal Dystonia; ED = Embouchure Dystonia

7. 2. 3. Instruments

The first main topic of the investigation was the experience with the received music education. In the absence of a measurement tool specifically developed for this construct, a scale measuring a similar concept, the Student-Instructor Relationship Inventory (SIRS) (Creasy, Jarvis, & Knapcik, 2009; Creasey, Jarvis, & Gadke, 2009) was selected and participants were asked to report about one instrumental teacher whom they worked with and found most influential. The SIRS measures the relationship between the student and teacher on an anxiety-connectedness axis and has been reported to have good psychometric properties (α = .87 in the anxiety factor and α = .92 in the connectedness factor) (Creasy, Jarvis, & Gadke, 2009). Additionally, it has the benefit of targeting college-level students – the age group where most of the professional teaching is happening – making this measurement tool even more appropriate. Since there were many topics in the interview studies relating to the profession-specific aspects of instrumental teaching, self-constructed questions were added to the survey. These were aimed at the content of the received teaching, with topics like received information about healthy playing technique and performance-related injuries, authoritative teaching style, socially prescribed perfectionism, and technique-focused teaching. In addition, following the qualitative data, questions were added about the participants' early accomplishments and the difficulty of the played material in relation to their peers. The 24 self-constructed items are presented in Appendix F.

The Mistake Rumination Scale (MRS) (Flett et al., 2020) was used to inquire about performance-related mistake rumination which was strongly supported by the qualitative data. This scale was tested on five samples (Flett et al., 2020) and was found to be valid to measure the construct ($\alpha > .81$, and all items loading .50 or greater in all samples).

Data was collected about the experienced trauma over the lifetime with the Trauma History Screen (Carlson et al., 2011), and additional self-constructed questions were added about significant changes in the participants' lives. These included events listed by the participants in Study 1., such as changing instruments, teachers or workplaces, and other personal events, such as becoming a parent or getting divorced. These potential risk factors and all scales employed are presented in Table 7.3.

Table 7.3.

Topics and Scales

Topic	Used scales
Experiences with music education	Student-Instructor Relationship Inventory (SIRS) (Creasy et al., 2009) Self-constructed questions (about teaching style, body mechanics, technique-focused teaching, and early success)
Mistake rumination	Mistake Rumination Scale (MRS) (Flett et al., 2020)
Trauma and change	Trauma History Screen (Carlson et al., 2011) Self-constructed questions

7. 2. 4. Procedure

After the participants received a link to the questionnaire, they were presented with a downloadable information sheet and were asked to give consent to the research team to use their anonymised data. Without consent, they could not proceed to the survey questions. The survey was open for two months.

7. 2. 5. Data analysis

For data analysis, SPSS and R software were used. First, responses with more than three data points missing were omitted manually. In the following analyses, the remaining missing values were replaced by means. The open questions regarding the instruments played were dummy coded twice, firstly, all different instruments were assigned a different number, and secondly, the instruments were grouped into six categories (woodwind, brass, string, piano, percussion, and plucked instruments) with one assigned number for each category. The location of the MFD symptoms in the group with MFD was also coded into three categories (upper extremities, embouchure, and other). Following this, descriptive tests were run to explore the sociodemographic variables.

In the second stage of the analysis, the instruments were inspected: Exploratory Factor Analyses (EFAs) and Confirmatory Factor Analyses (CFAs) were run on the scales to evaluate them and to test their internal consistency.

To map the differences in risk factors between the groups, t-tests were run on each variable and the relationship between them was tested with a Pearson r correlation. In order to create a comprehensive model of the variables, a logistic regression was used using the presence of MFD as a dependent variable. A detailed description of the tests and the procedure are presented in the result section.

7. 2. 6. Ethical considerations

Musicians who suffer from dystonia are vulnerable to psychological distress when asked to recall details about the condition which endangers both their livelihood and artistic outlet. The information sheet and accompanying documents were phrased with this in mind, avoiding negative language, and providing resources of support at the conclusion of the survey. Ethical approval was obtained from the Arts and Humanities Ethics Committee at the University of York, United Kingdom.

7. 3. Results

7. 3. 1. Descriptive statistics of participant sample characteristics

The average age of musicians with MFD (N=105) was 44.46 years (SD = 14.29) ranging from 21- to 83-year-old, and the average age of the onset was 35.57 years (SD = 16.743). They started playing the instrument at 13.09 years of age (SD = 7.14), although this number is skewed by some amateur players, who started playing between the ages of 35 to 50. After removing these outliers, the average age of starting instrumental education was 12.20 years. The participants suffered from the onset of MFD after 21.13 years of playing on average (SD= 13.49). 64.7% of the musicians considered themselves professionals with a further 15.2% responding “maybe”, and 20% of the sample was amateurs. Responses to the open question added at this point suggested that the majority of the professional musicians who reported “maybe” were unable to pursue their profession full time due to their symptoms at the time of their responses. 63.8% of the musicians were diagnosed by a neurologist, further 9.5% by another practitioner, 4.7% by fellow sufferer or musician, and 21.9% were self-diagnosed. There were 31 participants (29.5%) with embouchure problems in the sample with the rest reporting problems with their upper extremities, most often their fingers.

7. 3. 2. Factor analytic scale construction

Self-constructed music education scale. 20 items were examined for factorability. Half of the items were worded to express the opposite of the targeted construct to avoid participant bias; the scores for these items were reversed for the analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was .788, above the commonly recommended value of .6, and Bartlett's test of sphericity was significant ($\chi 2$ (190) = 1199.250, $p < .001$). All items correlated at least with one other (>0.3), showing that each item had some level of common variance with the other items, which suggested acceptable factorability. Table 7.4. presents the results of an Exploratory Factor Analysis with Promax rotation, using parallel analysis (Vivek et al., 2017) and loading values below .40 were suppressed (Hair, 2009). For this procedure, we used the full sample (N=175); the higher number of responses provided more data to establish the factors.

Table 7.4.

Factor loadings – EFA Pattern matrix "Music Education"

	Low health support and encouragement	Technique focused teaching	High teacher demands and authoritative style
Tech		.53	
No posture	.79		
Own technique (Rev.)		.79	
Expression (Rev.)	.46		
Avoid injuries (Rev.)	.76		
Unsatisfied			
Too much asked			.59
First try			.68
No health support	.55		
Give time (Rev.)	.66		
Unsure expectations			
Prescription			.74
Clear instructions (Rev.)	.62		
Encouragement (Rev.)	.53		
Concern over discomfort (Rev.)	.74		
Technical difficulty		.47	
Solving issues (Rev.)	.80		
Changed technique		.81	
Own approach (Rev.)		.41	
Self-efficacy (Rev.)			

Three underlying factors were identified, Low health support and encouragement, Technique focused teaching, and High teacher demands and authoritative style, explaining 27.1%, 12.9%, and 7.7% of the variance respectively. Two items were omitted because they did not meet the criteria of minimum loading of .40, and one because it cross-loaded on two factors. A confirmatory factor analysis was subsequently conducted on the remaining items and reinforced that the factor model was a good fit ($\chi 2$ (113) = 345.861, $p < .001$), and the three factors showed acceptable internal consistency (α = .783, α = 675, α = 757, respectively). This CFA model was used to calculate the factor scores for each factor and each participant, and these scores were used in the subsequent analysis. The items in the three factors are presented in Appendix F.

Early success scale. A second factor analysis was conducted on the items relating to early success on the instrument. The items were moderately correlating with each other (.453 to .666) showing common variance, but uniqueness. Kaiser-Meyer-Olkin measure of sampling adequacy (.767) and the Bartlett's test of sphericity ($\chi 2$ (6) = 248.514, $p < .001$) showed that the items met the requirements for factor analysis. The EFA was run on the full sample (N=175), with the use of parallel analysis and Promax rotation, and with the sample size and degrees of freedom in mind, the loading values below .40 were suppressed. The analysis and the following CFA showed one underlying factor clearly accounting for 65.4% of the variance with good internal consistency (α = .818) and was dubbed as "Early success". The loading table and the correlation table are presented in Tables 7.5. and 7.6.

Table 7.5.

Loading table – EFA pattern matrix, "Early success"

	Component 1.
Easy start	.770
Early success	.765
Quick improvement	.866
Ahead of class	.831

Table 7.6.

Pearson r correlation Matrix "Early success"

	Easy start	Early success	Quick improvement	Ahead of class
Easy start	1.000			
Early success	.45	1.000		
Quick improvement	.60	.51	1.000	
Ahead of class	.46	.54	.67	1.000

Two further CFAs were run on the selected items of the SIRS and the modified Mistake Rumination Scale. The CFAs reinforced the two underlying factors in the SIRS: anxiety around the tutor (α =.913) and connectedness to the tutor (α =.922) ($\chi 2$ (103) = 337.490, $p < .001$), and one underlying factor in the Mistake Rumination Scale (α =.897) ($\chi 2$ (14) = 60.026, $p < .001$). In both scales, means were used as scores for each participant and each factor in the subsequent analysis.

7. 3. 3. Comparing risk factors of matched samples of musicians with and without MFD

Independent samples t-tests were conducted to identify mean differences between both sub-samples (Healthy vs. MFD, N=88) in all potential risk factor variables (Table 7.7). The analysis showed that musicians with dystonia suffered from more performance-related mistake rumination and had significantly more success in their early careers. In addition to this, they had significantly lower health support and encouragement (Factor 1.) and more demands were placed on them with an authoritative teaching style (Factor 3.).

Table 7.7.

Comparison between musicians with and without MFD

Risk factor variable	Healthy M(SD)	MFD M(SD)	*t*	*df*	*p*	Cohen's d
SIRS Anxiety around tutor	2.40 (0.93)	2.78 (1.06)	1.78	86	.078	0.28
SIRS Connectedness to tutor	3.74 (0.88)	3.49 (0.87)	1.35	86	.180	0.38
Mistake rumination	2.17 (0.72)	2.75 (0.85)	3.45	86	< .001***	0.73
Low health support and encouragement (Factor scores for factor 1)	-0.27 (0.90)	0.10 (0.77)	2.12	86	< .005**	0.45
Autonomy in instrumental technique (Factor scores for factor 2)	-0.15 (0.96)	0.12 (0.99)	1.33	86	.184	0.28
Demands and authoritative teaching (Factor scores for factor 3)	-0.11 (0.88)	0.24 (0.75)	2.03	86	< .005**	0.43
Early success	3.30 (1.00)	3.92 (1.02)	2.83	86	.006**	0.60
Trauma frequency	1.81 (2.04)	1.95 (1.79)	0.33	86	.740	0.07
Significant life event frequency	2.04 (1.65)	2.52 (1.54)	1.39	86	.166	0.29

7. 3. 4. Correlations between risk factor variables

To test the shared variance in the risk factor variables a correlation table was created which shows a strong correlation between the self-constructed scale's factors (Health and encouragement, Autonomy in instrumental technique, Demands and authoritative teaching) and the SIRS scale's "anxiety around tutor" factor (Table 7.8). Moreover, there is a strong negative correlation between connectedness to the tutor (SIRS scale) and the first factor (Health and encouragement) of the self-constructed scale, and a positive correlation between anxiety around the tutor (SIRS scale) and the mistake rumination scale.

Table 7.8.

Pearson r correlation matrix for risk factor variables

Variable	SIRS connect	SIRS anxiety	Mist. ruminat.	Low health supp.	Autonomy	Demands	Early success	Trauma
SIRS connect	-							
SIRS anxiety	-0.54*							
Mist. ruminat.	-0.14	0.48**						
Low health supp.	-0.68**	0.44**	0.17					
Autonomy	-0.16	0.51**	0.26*	0.12				
Demands	-0.09	0.52**	0.37**	0.18	0.22*			
Early success	-0.14	0.22	0.13	0.12	0.01	0.06		
Trauma	0.15	0.16	0.21*	-0.12	0.07	0.15	0.10	
Change	-0.05	0.24*	0.27*	-0.002	0.15	0.26*	0.29*	0.28**

Note. SIRS = Student-Instructor Relationship Scale; probability values are calculated, and r correlations marked with * where values lower than .005 and with ** where values lower than .001

7. 3. 5. Logistic regression

Considering the rather frequent moderate to high correlations between risk factor variables, subsequently a logistic regression was run on the matched subsample of MFD sufferers and healthy musicians (N=88), in order to identify the most relevant risk factors for developing MFD. As an outcome variable, being affected by MFD was coded with 1 and not being affected with MFD with 0. All nine predictor variables were added to the model: anxiety around the tutor (SIRS scale, factor 1), connectedness to the tutor (SIRS scale, factor 2), performance-related mistake rumination, Health and encouragement (self-constructed scale, factor 1), Autonomy in instrumental technique (self-constructed scale, factor 2), Demands and authoritative teaching (self-constructed scale, factor 3), early success, trauma frequency, and significant life event frequency. Age and gender variables were also included in the model to control for their possible effects. Following this, in order to simplify the model and to avoid overfitting, risk factor variables with Wald statistics lower than 1 (SIRS connectedness to the tutor, trauma frequency, change frequency, age, and gender) were excluded from the analysis in a backwards fitting approach.

The results indicate that there are two highly influential, significant risk factor variables contributing to the construct: Mistake Rumination and Early success, two variables showing non-significant trends and two non-significant variables where the estimates show the predicted direction. With the inclusion of these risk factor variables, a significant model was observed ($\chi^2(80) = 22.681$, $p < .001$), Nagelkerke $R^2 = .306$), which predicted 71.2% of the cases correctly. The coefficient table is presented in Table 7.9.

Table 7.9.

MDF Risk Factor Coefficients from Logistic Regression

			Confidence interval		Wald Test		
	Coefficient estimate	Odds ratio	Lower bound	Upper bound	Wald Statistics	df	p
(Intercept)	-2.78	0.06	- 5.29	-0.28	4.74	1	0.029
Mist. ruminat.	0.94	2.56	0.24	1.64	6.95	1	0.008
Early success	0.66	1.94	0.16	1.16	6.82	1	0.009
Low health supp. (F.1.)	0.63	1.89	-0.036	1.31	3.44	1	0.064
SIRS anxiety	-0.72	0.48	-1.53	0.09	2.98	1	0.084
Autonomy (F.2.)	0.37	1.45	-0.21	0.96	1.55	1	0.212
Demands (F.3.)	0.43	1.55	-0.25	1.12	1.54	1	0.213

Note. Group with MFD coded as class 1. SIRS = Student-Instructor Relationship Scale.

7. 4. Discussion

The present study approached the question of the aetiology of MFD from a new perspective, placing it in a broader context. It can be concluded that there is evidence that apart from the frequently cited genetic predisposition (Schmidt et al., 2009), personality traits, maladaptive cognitive strategies, and overuse (Altenmüller & Jabusch, 2009; Altenmüller et al., 2014; Enders et al., 2011; Sadnicka, et al., 2018), external social factors might also play a part. There were significant differences between musicians with MFD and healthy musicians in terms of the education they participated in; musicians with MFD were more likely to receive less information about healthy playing technique, higher demands were placed on them with an authoritative teaching style, were less encouraged, and excelled at their instrumental studies, playing more demanding materials than their peers. Performance-related mistake rumination was also added to the already suggested maladaptive cognitive strategies and it was identified as a potential risk factor. Two of these factors were highly significant contributors to the logistic regression model, mistake rumination and early success; other educational factors showed significant differences between the groups in the t-tests and were not-significant trends, showing the predicted direction in the regression model.

Given that MFD is a highly task-specific condition (Hofmann et al., 2015), it seems difficult to fully understand it without considering the context in which the affected skill was learned, practised, and performed. The process of movement acquisition can provide further clues for understanding the condition's aetiology, moreover, it might help us to understand the task-specific nature of the disorder; a characteristic that the current models cannot fully explain (Sadnicka et al., 2018).

7. 4. 1. Playing mechanisms

Much has been written about how years of excessive repetition of the motor skill is a prerequisite for being affected by MFD: the onset usually happens to trained professionals after many years of practice and performance, most often in their mid-30s (Altenmüller & Jabusch, 2010; Sussman, 2015). However, what kind of movement patterns are being repeated, i.e., the quality of the playing mechanisms might be equally important as the quantity of the practice hours. Many musicians practise excessively without being affected by MFD; one explanation for this is the presence of genetic predisposition (Schmidt et al., 2009); however, it is possible that repeating less efficient movement patterns might also play a role. The quality, i.e., the way *how* the playing task is executed is largely determined by how it was learned in the first place. The investigations into the educational context show that there are some distinct characteristics of the received tuition of musicians who later were affected by MFD.

Training professional musicians requires a special setting that largely differs from traditional classroom education. Through the frequently delivered individual sessions, the instrumental teacher gains a profound influence over a limited number of students (Gaunt, 2011; Patston, 2014). This master-apprentice model of teaching happens in relative isolation (Haddon, 2009), is mostly unsupervised, and has no in-built mechanisms for quality control (Kemp, 1996). The content of the teaching is often the replication of the teacher's own education or personal experience (Mills & Smith, 2003; Visentin et al., 2008), and the centre of the attention is the musical output with much less attention to the physical movements or the posture the musicians use to create it (Chan & Ackermann, 2014). Moreover, music educators are often not well-informed about anatomically correct and instrument-specific body mechanics (Visentin et al., 2008), so students' unhealthy postures and inefficient techniques might be undetected and unchallenged, especially if the individual is still able to produce the expected output. As a prominent example, Glenn Gould played flawless concerts with a clearly distorted and unhealthy posture, and while he had not been diagnosed with MFD in his lifetime, the movement patterns observed in video recordings led experts to believe that he was affected by the condition (Wilson, 2000).

What is clear, however, is that inefficient playing mechanics can overload the joints and the musculature, and lead to physical problems (Chan & Ackermann, 2014). There are strong established links between playing-related musculoskeletal disorders, overuse, and unhealthy postures in musicians (Steinmetz et al., 2010), and overuse has been proposed as a triggering factor for MFD as well (Baur et al., 2011; Altenmüller et al., 2014). This suggests that the biomechanical quality of the playing technique might play a part in developing the condition.

Results from the self-constructed scale's first factor, "low health support and encouragement" shows the tendency that teachers of the musicians who later developed MFD cared less about educating their students about healthy playing technique and correct posture and were less concerned about performance-related pain or injury. It is an established fact that pain or discomfort experience can modify established movement patterns (Sterling et al., 2001) to avoid pain- or discomfort-triggering movements, moreover, the intensified somatosensory input may "lead to a degradation of sensorimotor representations at several levels of the sensorimotor circuits" (Altenmüller & Jabusch, 2009, p. 146). Fatigue and pain can also lower the motor system's capacity to meet the demands of the performance. As Sadnicka et al. (2018) noted, these alterations of muscle recruitment, which can be inappropriate and inefficient, can have neurological consequences: if the neural representation of the skill cannot accommodate the new movement pattern, the performance will be impaired. In other words, unhealthy playing mechanisms, especially the ones which lead to pain or injury, can lead to developing compensatory movement patterns, and simultaneously, neurological changes. Unfortunately, many musicians keep playing with pain and injury, furthering this deterioration, due to the "no pain, no gain" culture among professional musicians and the stigma around performance-related pain which discourages musicians to seek help for their discomfort or pain (Ackermann, 2017). The primary music teacher's role in compensating for this negative message is extremely important because they can have a profound effect on their students' health and instrument-related behaviours, and at a younger age, students are more malleable to change maladaptive habits (Cruder et al., 2020).

7. 4. 2. Early success

Apart from the decreased motor capacity following pain, there are other situations in which the young musician is challenged to play more difficult materials they are capable of: during the learning process. While the instrumental technique is still developing, choosing an adequate repertoire, which requires enough challenge for development but does not overwhelm the student, is extremely important (Patston, 2014). If the developmental trajectory of the student is not kept in sight, and the student is pushed over the boundaries of normal motor development, a similar discrepancy between skill and demand presents itself, which can pose a risk for MFD (Sadnicka, et al., 2018).

In the dataset, musicians with dystonia reported significantly more early success (i.e., playing more demanding materials than their peers and facing challenging performance opportunities). Assigning difficult materials to students might be due to misinterpreted levels of capability from the teachers' part, but it is also possible that these young students showed great aptitude. This idea is further reinforced by the fact that musicians affected by the condition are often soloists (Lim & Altenmüller, 2003; Sussman, 2015) or playing in other esteemed positions, which suggests outstanding talent.

Also, the rapid advancement in playing the instrument might also be linked to the age these musicians began their instrumental studies: the average starting age for the participants with dystonia was 12.20 years (after removing the amateur outliers who started over 35). Children's learning strategies undergo certain changes as their metacognition and verbal working memory develop. Very young children learn based on mimicking and repeating: the process is mostly unconscious and is not accompanied by cognitive verbal processes (Masters et al., 2013). This is called implicit learning or external focus of attention in the literature, and it produces robust, and rapidly automatised movement patterns, underpinned by neural efficiency (Zhu et al., 2014). Examples of these might be walking, manipulating objects, or riding a bicycle. As the child develops a more and more substantial capacity for metacognition, more cognitive skills are used in the process: conscious, analytical planning and testing out certain movement patterns. This is an explicit way of approaching the task at hand, with more conscious control involved in the process. This change in the way of learning is dependent on the task and there are individual differences; however, the ability rarely develops fully before the age of 11 (Gathercole et al., 2004; Masters et al., 2013). The fact that the average starting age in the sample was 12.20 years, and the literature reported similar findings across several samples of musicians with MFD (Altenmüller, et al., 2014; Schmidt et al., 2013) suggests that musicians who later developed MFD employed a more explicit strategy, and more internal focus when acquiring the skill. While the literature clearly shows the superiority of implicit learning or external focus (Wulf, 2013) providing evidence that learning with an external focus enhances efficiency (Zachry et al., 2005), effectiveness (Wulf & Lewthwaite, 2010), technical precision, and musical expressivity in music performance (Mornell & Wulf, 2019), the findings regarding the attention of focus in the early stages of learning have been so far inconclusive (Stambaugh, 2017). It has been hypothesised that children with high motor ability benefit from explicit learning (Maxwell et al., 2017); therefore, it is possible that a more explicit strategy provided an asset in the early years of education, helping these young musicians to improve quickly, even if the strategy is not advantageous long-term, especially after the basics of the skill are acquired. Additionally, in late starters, peer pressure also might play a role in playing complex materials early: observing the accomplishments of other students of the same age might prompt both the teacher and the student to try to "catch up".

What is clear, however, is that there are neurological consequences of the late start: the networks underpinning the complex movements needed for playing are developing more optimally if the individual starts playing before the age of 7 (Altenmüller et al., 2014);

therefore, the late start has been identified as a risk factor for developing MFD (Altenmüller et al., 2014; Schmidt et al., 2013).

In summary, playing challenging materials without fully mastering the required motor skills is a risk factor in developing MFD. The reasons for choosing such a repertoire might be manifold: late start, which can be associated with different learning strategies and possibly peer pressure, or simply, the aptitude of these students. Nevertheless, both a late start and the mismatch between the established motor skills and the requirements of the repertoire seem to put musicians at risk of developing MFD.

7. 4. 3. Lack of encouragement and authoritative teaching style

Apart from how and what is being learned in the educational context, the atmosphere and the teaching style also seem very influential. Items relating to the received encouragement, and positive feedback were found to be significantly different between the groups with musicians with dystonia reporting a less favourable and less supportive environment. Moreover, the SIRS's subscale, "anxiety around the tutor" approached statistical significance, with the dystonic participants reporting more anxiety around their teachers, which also points towards an adverse experience with the individual tuition. The relationship between motor learning and feedback has been examined in sports settings: Avila et al. (2012) found that encouraging and positive feedback enhances the learning and the performance of the motor task. It also seems logical that if the motor skill is repeated with a negative connotation and emotional content, it might influence the future recall of the skill (Juhan, 2003) as well as the learning process. The link between negative emotions and the onset of the disorder in musicians with already existing anxiety and perfectionism has been suggested; as Altenmüller & Jabusch write (2009): ”It is possible that emotionally induced motor memory consolidation may facilitate the onset of dystonia in the subgroup of patients with these psychological conditions" (p. 151).

This unfavourable environment was also underpinned by a prescriptive and authoritative teaching style and high demands. Strict constraints on the performance are an inevitable part of playing classical music: many aspects of the performance are subscribed to the player, especially in group settings, such as orchestral or chamber music work, leaving little room for spontaneous changes. These musical constraints make classical musicians more vulnerable to developing MFD than jazz or pop musicians who have more freedom to modify the played material (Altenmüller & Jabusch, 2009).

As inevitable as some restrictions are, there are aspects where the musician should be able to make their own decisions, especially in an educational setting, in order to explore their individual interpretation of the pieces and their technical capabilities (Jørgensen, 2000). The autonomy of the student is an important contributor to optimal learning (Katz & Westera, 2019; Wulf & Lewthwaite, 2016): it has been associated with self-efficacy, motivation, attention, and positive cognitive processes during the task (Lemos et al., 2017).

If the general restrictions of classical music are furthered by the teacher's expectations, and the students must play in a prescribed way, the required precision also increases, and with it, the risk for developing MFD. The more highly specialized a skill's neural representations are, the less ability they have to adapt to different task requirements (Sadnicka et al., 2018). Moreover, demanding one specific way of performance and interpretation makes the difference between success and failure even smaller. The neurological consequences of placing demands on students that they are not able to meet have already been discussed, but it also has psychological consequences. Trying to meet unattainable demands can provoke anxiety, which has already been linked to the onset of MFD (Enders et al., 2011), perfectionism, a trait which has been repeatedly reported as a typical characteristic of musicians with MFD (Jabusch & Altenmüller, 2004; Jabusch et al., 2004), and rumination, especially following negative feedback (Nepon et al., 2011).

7. 4. 4. Mistake rumination

There are established links between socially prescribed perfectionism, anxiety, and rumination (Flett, Madorsky et al., 2002), and the importance of the social and interpersonal aspect in developing distressing, intrusive thoughts have been thoroughly discussed in the literature (Nepon et al., 2011). To put this into the context of music performance, inquiries were made specifically about performance-related mistake rumination and found that musicians with dystonia ruminate over performance mistakes significantly more than their healthy counterparts. It seems feasible that apart from the individual and innate trait of perfectionism which makes the individual more sensitive to negatively perceived feedback (Hewitt et al., 2006), the social environment also plays a role, given that the ruminative thoughts often appear in response to an external trigger. How these distressing events are processed, and the content and amount of rumination are dependent on the levels of social anxiety, but also, on the received feedback following the event (Morgan & Banerjee, 2008). In other words, the already mentioned unfavourable educational context might have contributed to the mistake rumination which developed in the musicians who later were affected by MFD.

7. 4. 5. Trauma and change

There were no significant differences between the samples in terms of traumatic experiences, in spite of the fact that preceding traumatic events or significant change have been repeatedly mentioned in the literature (Schmidt et al., 2013; Tubiana, 2003), and also in the studies presented in this thesis. One possible reason for this is the chosen tool: the Trauma History

Screen (THS) is quite general, listing various traumatic events, from which some are not specifically linked to interpersonal relationships or music performance, such as accidents and natural disasters. Also, measuring the frequency of the suffered traumas might not provide sufficient data on the impact they had on the individual. It is clear from the literature about Post Traumatic Stress Disorders (PTSDs), that personality, gender, genetic predisposition, and the available support system can all alter how much the individual is affected (Broekman et al., 2007; Elwood et al., 2009). A recent paper (Alpheis et al., 2021) compared the childhood experiences of musicians with and without MFD using the Adverse Childhood Experiences Scale (ACE-S) and found that MFD sufferers experienced more emotional neglect during their childhood; this research tool specifically focuses on the family environment and does not include any other potential sources of trauma. Therefore, it seems that the early development and experiences in terms of trauma can be risk factors; however, other types of traumas are not significant predictors in the development of the disorder.

A self-constructed scale was also added to the survey, listing significant events which were found to be influential by Study 1. These included change in marital status, jobs, or teachers, becoming a parent, death of a close relative and similar items. Similarly to the THS, there were no significant differences between the groups. One reasonable explanation for this is that musicians with dystonia were asked to report about the year prior to the onset, while the healthy sample about the previous year. Since the survey was administered while the COVID 19 pandemic was still significantly influencing the lives of performing musicians, many healthy participants experienced more life-altering changes than they would have under normal circumstances.

In conclusion, while there is a growing amount of literature on the psychological and behavioural triggering factors in MFD, these have not yet been explored in a social and playing-specific context. While this study has not been able to show very strong and conclusive evidence, it still seems important to examine the developmental trajectories of these risk factors. This approach can not only enhance music educational practices in a broader sense but can specifically inform preventative strategies. It also has the added benefit of changing the narrative around the sufferers of the condition and shifting it towards a more compassionate and holistic understanding of the personal experience of the musicians.

7. 4. 6. Limitations

The most obvious limitation of this study is that it uses to some degree self-constructed, previously not tested scales. It was necessary to proceed with this method because of the lack of scales measuring the constructs highlighted in the interviews. Therefore, the development and validation of scales measuring the quality of the received music education are suggested to create a more reliable and valid understanding of the phenomenon.

Only 63.8% of the musicians with MFD were diagnosed by a medical professional; therefore, it is not possible to state with complete confidence that all the participants who reported having MFD are indeed experiencing symptoms of the disorder and not some other form of performance-related problem. However, as more and more information is available describing the condition's unique and peculiar symptoms, the decision was made to include all participants in the analysis who claim to have MFD.

Also, musicians with MFD were asked to recall personal memories, feelings, and psychological states prior to the onset. This was necessary because the main targets of the inquiry were the contributing factors, but obviously, it might not be fully reliable and carries possible personal bias. Moreover, there might be some other underlying psychological constructs that are contributing to these differences; systematic and holistic research including all these factors could offer further clarification. Nevertheless, this exploratory study highlights the importance of researching not only currently present traits in sufferers but also the developmental trajectory of these.

7. 5. Conclusions

In conclusion, mistake rumination and playing challenging materials prematurely possibly contribute to the onset of the disorder. Moreover, significant differences were found between the education of musicians with MFD and healthy musicians: it seems that those who developed the disorder learned less about healthy technique, were encouraged less, more demands were placed on them, and the received tuition followed a more authoritative style.

The musicians' lives who are struggling with the condition have to be viewed as complex, continuously evolving systems that are influenced by the environment. This can help us to clarify the aetiology of the condition and can inform preventative strategies.

This is only an early exploration, the first step towards these goals. More refined methodologies are needed to assess various contributing factors and more research to explore how these might impact the individual musicians. Also, as shown in Study 2.2, these characteristics and experiences greatly influence rehabilitation as well, so a clearer understanding seems essential in order to enhance the treatment strategies and provide better care for this vulnerable population.

Part III. General discussion and implications

Chapter 8. General discussion

8. 1. The triangulation of the findings

In the previous chapters, potential risk factors of developing MFD were examined from three different angles with distinctively different methodologies. The primary focus was to gain a better understanding of the condition's progression and onset, build a more holistic model of the disorder, draw conclusions in terms of complementing treatment approaches, and develop preventative strategies. This section will be discussing the first of these goals and will present a new, holistic model of the development of MFD.

The multifactorial nature of MFD has been acknowledged by previous research and it seems clear that the co-occurrence of various socio-environmental, psychosocial, psychological, and behavioural factors precedes the onset of the condition (Alpheis et al., 2022; Altenmüller et al., 2014; Enders et al., 2011; Sadnicka et al., 2018; Schmidt et al., 2013; Schneider et al., 2021). The elements of this complex web of potential risk factors are intertwined and influence each other deeply; therefore, can only be fully grasped and absorbed when approached from a broad and holistic perspective. To fulfil this goal, the analysis was based on Engel's (1977) biopsychosocial model (BPS model), enriched by a constructivist approach (acknowledging that individuals interpret their reality differently based on previous experiences) as suggested by Adler (2009). Furthermore, Ahn et al.'s (2006a; 2006b) systems-oriented framework provided further guidance in the development of the model. These theoretical perspectives are discussed in detail in Chapter 2., Section 2.3., titled "The holistic model". Applying the BPS model and systems thinking to the data highlights how these various internal and external influences prompt, manipulate, and even regulate each other.

In addition, the sequence of events and influences appear to be significant: as it was demonstrated in the presented studies, the onset of the symptoms is most likely the final stage of a long period of deterioration, occurring on a psychosocial, psychological, behavioural, and physical level. The discussion operates under the assumption that the personality, cognition, belief systems, emotions, behaviours, and reactions to external stimuli of an individual are shaped throughout their lives by their experiences, and the social and cultural context they live in (Adler, 2009; Van der Kolk, 2014). This ongoing construction of one's reality is based on the strong imprint of the earliest experiences which inform the subsequent development (Van der Kolk, 1994; Zarse et al., 2019), and this process has an ongoing influence not just on the personality and psychological constructs, but on the physical health of the individual as well (Kugler et al., 2012; Van der Kolk, 2014).

Therefore, opposing the previous chapters where various influences and risk factors were - for the sake of the clarity of the analysis - artificially grouped and separated, and discussed as individual entities, in the general discussion, they will be analysed chronologically, following the developmental trajectory of a musician. Accordingly, the obtained data will be organised around specific stages in a musician's career, starting from early childhood, through the education and professional life experiences to the onset of the condition. While every musician's timeline and encompassed experiences are different due to the diversity of their background, the instrument played, their gender, age at the onset, and educational and professional experiences, the triangulated data show certain trends and tendencies in this population.

I argue that this systematisation is more appropriate to understand the progression of the condition for two reasons. Firstly, it allows the exploration of the developmental trajectory of the condition by considering the intricate web of the potential contributing factors in chronological order, i.e., how certain experiences might inform the perception of the subsequent ones. Secondly, it provides a more personal, insider-view of the life stories of musicians with MFD, generating a narrative of events and influences rather than just a description of a set of symptoms, and propagating a more emphatic and compassionate attitude towards these individuals.

8. 2. The new holistic model

In the following sections, the discussion of the potential risk factors will be developed based on the data obtained from all three studies presented in this thesis. For the sake of consistency and simplicity, the studies will be referred to in the following way:

S1 - The constructivist Grounded Theory interview study with musicians with MFD (presented in Chapter 4).

S2.1 - Data relating to the potential risk factors of developing MFD, obtained from the semi-structured interview study with practitioners (presented in Chapter 5).

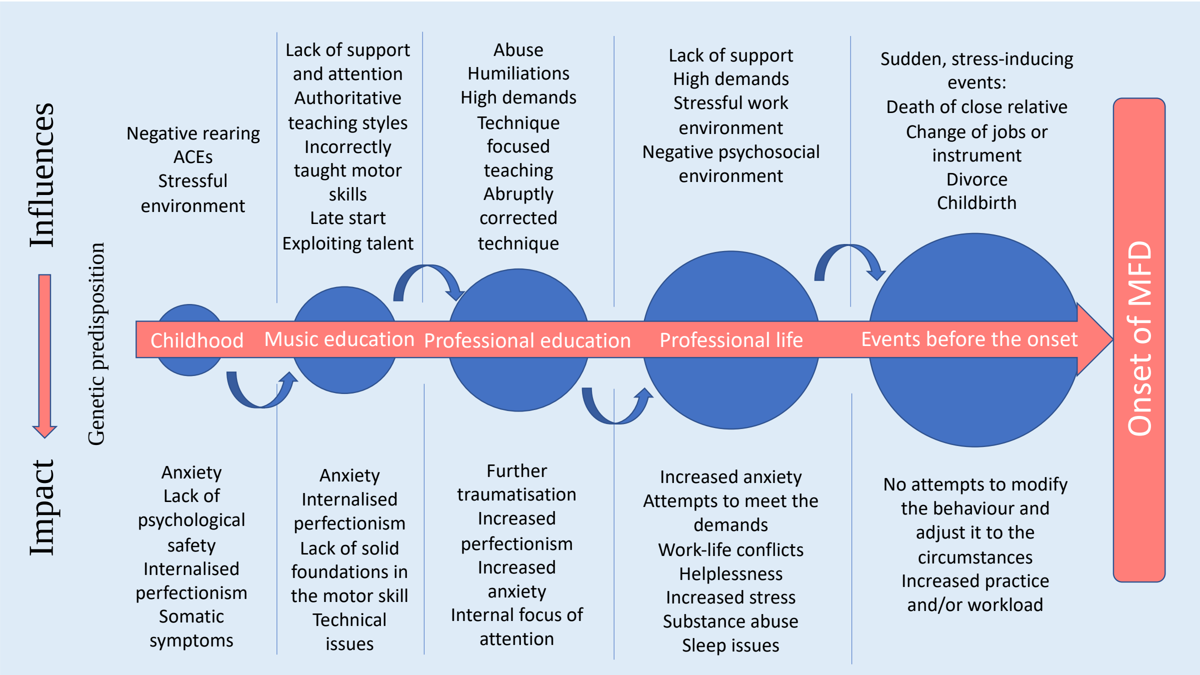
S2.2 - Data relating to rehabilitation strategies, obtained from the semi-structured interview study with practitioners (presented in Chapter 6).

S3 - The hypothesis-testing survey study to compare musicians with and without MFD (presented in Chapter 7).

Occurrences where the various types of data contradict each other will be marked and the implications discussed. The overarching model based on the triangulated data is presented in Figure 8.1.

Figure 8.1.

The holistic and chronological model of the development of MFD



8. 2. 1. Childhood

The qualitative interview data (S1; S2.1) has multiple mentions of adverse childhood experiences and stressful, dysfunctional home environments. Examples include a participant in S1 who was adopted into a different country, far from their own culture and birth parents, and described their stepparents as emotionally and physically abusive and the experience as traumatic. Several others reported having been raised by a parent or parents who struggled with mental health issues, and in one case, addiction, or were controlling and had unreasonably high expectations towards them in terms of academic achievement. One participant from S2 explained how one of their patients was locked in their room for several hours to practice and was emotionally abused if they stopped playing. These experiences differed greatly in terms of severity and reported frequency, with some participants not disclosing any information and others providing a detailed description of their difficulties.

The obtained narratives, however, describe environments characterised by a series of negatively perceived events and psychological pressure, which was inflicted upon the musicians by the closest relatives and social actors in their lives.

Schneider et al. (2021) enquired about the early experiences of musicians with MFD and presented similar results: in their six case studies, all participants experienced some form of early psychic traumatisation, such as serious illness in the family and emotional and/or physical abuse, which resulted in maladaptive coping strategies and psychological vulnerability. The qualitative, constructivist, and participant-led methodology and the small sample size in both studies (S1; Schneider et al., 2021) do not allow for generalisation; however, it highlights how early experiences might have a role in the development of maladaptive psychological traits, cognitions, coping strategies, and behaviours, which subsequently and indirectly might have furthered the onset of the disorder in later years.

The relationship between negative rearing and physical and mental health in adulthood received substantial attention in the past decades. It has been concluded that the events, circumstances, and parental attitudes shape significant aspects of adult life, such as personality (Fletcher & Schurer, 2017), identity (Dewey, 2021), and mental and physical health (Máté, 2011; Petruccelli et al., 2019; Van der Kolk, 2014; Zarse et al., 2019). Since the development of the most frequently used scale, the Adverse Childhood Experience (ACE) scale (Felitti et al., 1998) a wide range of psychological and physical diseases have been linked to maltreatment in childhood and negative experiences with rearing. Casual connections have been identified between ACEs and various mental health issues, such as depression, addictions, psychosis, Post Traumatic Stress Disorder, insomnia, and many somatic illnesses, such as autoimmune, gastrointestinal, pulmonary, and cardiovascular diseases, and cancer (see Zarse et al., 2019, for a comprehensive summary of the research). Additionally, various somatic symptoms have been reported in children and adolescents who experienced adverse rearing, such as unexplained pain and muscular tension (Kugler et al., 2012; Van der Kolk, 2014), and heightened levels of anxiety in response to parental anxiety and attachment issues (Van Brakel et al., 2006). The pathological mechanisms behind these links are not fully clarified but it has been shown that being exposed to negative rearing in the developmental stages can produce long-lasting neurological effects: the brain systems involved with responses to stress and formulating social connections seem to undergo structural and functional changes in response to these experiences (Teicher et al., 2016). More specifically, the threat reactivity of the amygdala (Fonzo, 2019) and hypothalamic-pituitary-adrenal (HPA) axis (De Bellis & Zisk, 2014) might be increased after sustained exposure to stress from the social environment.

Arguably, these changes have an impact on the individual's psychological state and social relationships. The increased sensitivity to stressful situations, i.e., hyper-vigilance, can corrupt the sense of psychological safety (Fang et al., 2014; Wanless, 2016), and can prompt chronic anxiety and perfectionism, the latter potentially developing as a defence mechanism in children in response to the abusive environment. There are two models explaining this phenomenon, the social reaction model (Domoncus & Damian, 2018; Flett, Hewitt et al., 2002) which describes perfectionism as a tool to avoid punishment in a harsh environment, and the social expectation model (Damian et al., 2013), in which the child tries to create a safer environment by attempting to meet the parental expectations. Despite some differences, both models acknowledge that the evolving perfectionism functions as a coping strategy. Linking the heightened levels of perfectionism and anxiety which have repeatedly been reported in at least a portion of musicians with MFD (Enders et al., 2011; Jabusch & Altenmüller, 2004; Jabusch et al., 2004; S1; S2.1) and the potential negative rearing and childhood experiences of musicians with MFD (S1; S2.1; Schneider et al., 2021) reveals a probable connection between adverse childhood experiences and the onset of MFD.

To gain a better understanding of this relationship, Alpheis et al. (2022) collected data from musicians with and without MFD regarding their rearing with the Childhood Trauma Questionnaire (CTQ) and the Adverse Childhood Experiences Scale (ACE-S), moreover, an additional qualitative question was added to provide space for the participants to share any personal experience from their early years which they perceived as traumatic. The quantitative measures showed a trend towards higher rates of emotional neglect in musicians with MFD, which was emphasised further by the qualitative entries, thus reinforcing the hypothesis that in musicians with MFD, the potential starting point of the developmental trajectory of their negative psychological traits might be an adverse rearing experience. Moreover, the analysis of the qualitative entries revealed that musicians with MFD were pressured more by their parents to perform well on their instruments.

Examples of the parents' socially prescribed perfectionism projected specifically on instrumental playing and success appeared in both interview studies (S1; S2.1). These findings point towards the construct of achievement-oriented psychological control (Soenens et al., 2010), which, opposing dependency-oriented psychological control, is practised (either consciously or unconsciously on the parents' part) with the goal of prompting their children to meet high standards by displaying controlling behaviours. It has been linked to anxiety (Van Brakel et al., 2006), self-criticism, and low self-esteem in children and its potential source is the parents' own perfectionism and anxiety (Soenens et al., 2005; Soenens et al., 2010). In such a perfectionistic environment, the child is even more likely to adhere to the parents' expectations and strive for excellence in the hope to secure attention and safe attachment, as described in the social expectations model (Damian et al., 2013).

In summary, there is some evidence that at least a portion of musicians who later were affected by MFD had a history of childhood maltreatment, negative rearing, and stressful home environments which potentially led to lasting neurological changes in their brain and negatively impacted their physical and mental health. Moreover, it is possible that they had been exposed to socially prescribed perfectionism, achievement-oriented psychological control, and anxious rearing which enabled the development of perfectionist tendencies in them by internalising the parents' attitudes in order to gain acceptance or attention. As a result, by the time these young musicians started their instrumental studies, they possibly already had been more susceptible to anxiety, perfectionism, and hyper-alertness to potential dangers; a highly vulnerable state which is known to compromise psychological safety (Fang et al., 2014; Wanless, 2016), and capacity for learning (Holley & Steiner, 2005). In the affected musicians, this predicament possibly impacted the social interactions and engagement with their teachers and peers and would have required special attention.

8. 2. 2. Music education

The topic of music education was the most discussed in this dissertation so far. The various types of data reinforced that the educational experience, i.e., the quality and content of the received teaching, student-teacher relationships, and the atmosphere in the lessons, plays an important role in the development of the disorder. The findings provide information about various contexts in which the later affected skill was learned and performed; these will be discussed under two main subheadings: the section titled “Young learners” collects and analyses all the information obtained about the early years of music education, while the section titled “Professional education” is about the musicians' experiences in specialised education, such as conservatoires.

Young learners

As discussed in the previous section, at least a portion of musicians who were affected by MFD later, might have entered the music education system as young learners in a psychologically vulnerable state due to their previous experiences, i.e., predisposed to anxiety and perfectionism, and highly sensitive to potential stressors (Alpheis et al., 2022; Schneider et al., 2021). Unfortunately, this new environment did not prove to be supportive for many: reports from S1 and S2 highlighted negative experiences with the received music tuition in these early years. These included high demands but lack of support, and distant, unresponsive, and authoritative behaviours on the teachers' part. Moreover, there were several mentions of unsolved and persistent technical issues which continued into the musicians' later careers (S1), but at the same time, early success, and rapid development (S1; S3). Still in the domain of early music education, the age when the musicians began their studies also seems significant: those who later developed MFD started playing their instruments several years later than their peers (S1; S3). This particular characteristic was also found in various different samples across many datasets (Altenmüller et al., 2014; Schmidt et al., 2013).

To understand the young musicians' position in these contexts, the starting point needs to be their psychological vulnerability because to a certain extent, it informs how the subsequent events are perceived (Fang et al., 2014; Wanless, 2016). In fact, it is possible that the reported negative experiences (S1; S2.1) were magnified through the lens of the previous traumatisation due to the increased sensitivity of the musicians. Nevertheless, the subjective nature of the impression of the social environment and the incidents taking place in it does not change their psychological impact: negative perceptions and the lack of psychological safety interact with all aspects of cognitive and motor learning and can diminish the young musicians' ability to build social connections and acquire and absorb new information (Holley & Steiner, 2005; Wanless, 2016). In order to counteract or at least, neutralise some of the effects of psychic traumatisation, a psychologically safe, accepting, and welcoming learning environment would have been crucial (Holley & Steiner, 2005; Thomas et al., 2019).

Due to the aforementioned individual perception, it is difficult to assess if these conditions were met. In general, the empirical research conducted on one-on-one instrumental educational practices at a beginner level is limited (Patston, 2014; Rostwall & West, 2003). Due to the individual nature of the lessons in traditional music education, an instrumental lesson is “a hidden and almost secret activity that goes on privately behind closed doors” (Rostwall & West, 2003, p. 214). The available data, however, shows that some of these practices provide a less than ideal environment for young musicians. Rostwall & West (2003) present a glimpse into beginner-level instrumental tuition: when analysing 11 lessons, they found that teachers often abused the asymmetrical distribution of power by using sarcastic comments in response to their students’ initiatives and questions. Also, when unable to meet the task requirements due to a lack of support or experience, many students were regarded as “untalented or less motivated” (p. 221). In this study, it was also observed that the music had to be played in an “approved” manner” (p. 222) and the teachers did not change their pedagogical approaches in response to the individual students’ needs but followed a habitual, and arguably, traditional, teaching method with everyone. While this is only a cross-section of a very limited sample, the in-depth analysis indicates that these practices might be damaging in various ways.

Prescribing the “right” way to play and rejecting the performances which fall outside the set criteria can foster perfectionism: as Patston (2014) points out, teachers’ attitudes towards the performance and the vocabulary used can unknowingly induce perfectionistic tendencies during the learning process. Striving towards these ideals can lead to anxiety in the student which can develop from ages as young as three-four, and these early performance experiences can shape the students’ responses to subsequent ones (Boucher & Ryan, 2011).

As Patston and Osborne (2016) explain, this process can be understood as conditioning which starts at the beginning of the instrumental studies and continues throughout professional life with each performance experience imprinting on the next one. This influence is possibly mediated by pre-and post-performance variables (Mineka & Zinbarg, 2006), such as the received information and guidance before performances and the quality of feedback afterwards. Thus, anxiety around the performance can be "learned" from negative experiences depending on the responses from the environment. Perfectionism and anxiety are the most frequently reported characteristics of musicians with MFD (Enders et al., 2011; Jabusch & Altenmüller, 2004; Jabusch et al., 2004), and these findings were reinforced by the present thesis as well. Extrapolating from this, it is possible that the roots of these traits might be found in early learning and performance experiences.

The other main topic in early instrumental learning is the content, i.e., *what* is being learned. Participants from S1 frequently reported having technical issues in certain aspects of their playing from the very beginning, which intensified with the increasing difficulty of the material they played. Participants from S2 pointed out that many of their patients or clients had habitual and established inefficient technique and poor postures, and S3 reinforced that musicians with MFD did not receive quality information about the healthy and efficient biomechanics of the playing technique.

The importance of the first years of instrumental learning cannot be overstated. The biomechanical foundations of the instrumental technique are laid down, such as sound production, breathing, hand positions, and posture, which, while they are malleable to a certain extent, serve as a basis for future learning and more complex movement patterns (Waters, 2020a). These functions are encoded via neuroplasticity which is triggered by the repetitions of the movement sequence, establishing automated movement patterns

(Altenmüller & Gruhn, 2002). The process of motor learning involves "chunking", i.e., grouping the components of the repeated movements sequentially, which increases neurological and technical efficiency and automatisation by employing the established "chunks" in consecutive repetitions (Sadnicka et al., 2018). Thus, this early correct "coding" of the specific elements, i.e., building blocks, of the motor skill is important to enable the subsequent learning of more intricate materials.

Beginners need appropriate guidance to achieve fluency, i.e., performing highly complex movements with accuracy and minimum effort, in their motor movements when playing the instrument (Gonzalez-Sanchez et al., 2019). The lack of this guidance can result in technical difficulties, or occupational injuries later in life (Niijima et al., 2021; Waters, 2020a): tertiary music students in Waters' study (2020a) originated their performance-related pain and injuries in the incorrectly taught technique in the early years of their education, and the author concluded that "there may be some long-term adverse consequences for students whose early learning experiences are less than ideal" (p. 228). Considering the persistent technical difficulties reported by participants in S1 and that the onset of MFD is often linked to overuse and occupational injuries (Altenmüller et al., 2014; Sadnicka, 2018), it is possible that the poor pedagogical approaches and lack of attention to movement laid the foundations to the later acquired MFD.

Probably one of the most crucial contributing factors to the development of healthy movement when playing is the teachers' feedback (Altenmüller & Gruhn, 2002), especially with younger children who have not yet developed the cognitive and analytical skills to correct themselves (Masters et al., 2013). As Altenmüller and Gruhn (2002) articulate, "neuronal networks established during music learning may depend on teaching strategies" (p. 63). Unfortunately, teachers often direct their attention towards the development of other abilities, like reading the music score (Rostwall & West, 2003) or the produced sound

(Gonzalez- Sanchez et al., 2019), paying little or no attention to the movement performed to achieve it. As a result, students are "left alone with regards to many aspects of their musical development, especially motor learning" (Rostwall & West, 2003, p. 220). Another reason for the limited guidance in the correct biomechanics of playing the instrument might be that music teachers are often not well equipped with the necessary anatomical knowledge to direct and correct motor learning; therefore, they replicate their own education (Détári & Nilssen, 2022; Visentin et al., 2008). As a result, young students might not get the right guidance, support, encouragement, and advice to develop a sustainable, robust, efficient, and biomechanically correct instrumental technique which could provide a strong foundation for subsequent learning.

Musicians who develop MFD later in life, also seem to start their instrumental studies slightly later than their peers. Participants from S1 shared stories about getting access to music education after several years in school or changing instruments due to interest or necessity in their early teens. One example is a participant from S1 who played the guitar for years, but after changing schools, they could not participate in the band rehearsals with their chosen instrument since the position was filled. The orchestra, however, was in desperate need of horn players, so they started playing it at the age of 13. Similar starting age (12.20 years) was reported in the survey sample (S3) and in other studies as well (Altenmüller et al., 2014; Schmidt et al., 2013) and it has been identified as a risk factor in developing MFD (Altenmüller et al., 2014; Sadnicka et al., 2016).

In the literature, the relationship between a late start and the development of the condition is often explained from a neurological viewpoint: neuroplasticity is at its peak in the first years of the child's life and the neural networks underpinning the complex motor movements required to play an instrument develop more optimally before the age of 7

(Altenmüller et al., 2014). However, when examined in the social and cultural context and considering the young musicians' developmental stage and possible psychological vulnerability, the late start might aggravate additional cognitive, psychosocial, and behavioural factors.

Children before the age of 7 and in their early teens learn very differently. Until the metacognition required for reasoning and planning develops after the age of 11 (Gathercole et al., 2004; Masters et al., 2013), the process is primarily based on imitation. Young children mirror the movements and behaviours of the adult without formulating evaluations of their own performance or making conscious decisions about how to improve it. This is known as implicit learning and combined with the malleable neural networks and rapid neuroplasticity typical at this age, it is a very effective way to produce automatised movement patterns, supported by a stable and robust neural network (Altenmüller et al., 2014; Zhu et al., 2014). After the age of 11, the developing conscious planning and analytical thinking allow the child to approach the task explicitly: the movements might be observed and evaluated, and steps planned out for further improvement (Gathercole et al., 2004). There is no clear consensus in the literature on whether this strategy is superior in the early stages of learning (Maxwell et al., 2017; Stambaugh, 2017), but children with high motor ability might benefit from it (Maxwell et al., 2017). This idea is reinforced by the rapid advancement and early successes of the participants in S1 and S3: they appeared to have a great aptitude and were quickly dubbed as "talented" by their teachers and educational environment.

The narratives of the participants from S1 described this stage as the most fulfilling chapter of their lives. Given that most of them strived to be perfect to meet their parents' or teachers' expectations to gain attention and acceptance, these circumstances offered an opportunity. Possibly due to their aptitude and age-appropriate analytical thinking they were able to surpass their peers and prove themselves to authority figures. This early, rapid success also reinforced their identity as musicians and served as a resource for acknowledgement. As Alpheis et al. (2022) hypothesise, for musicians with MFD, starting to play music intensely might also be used as a means of escapism from previous traumatic experiences. However, this early success might be a double-edged sword; musicians with MFD reported (S1) that their teachers fully exploited their talents, often challenging them beyond their capabilities. Several participants were competing on an international level only after 3-4 years of learning and playing in highly esteemed orchestral positions with much more accomplished and/or older students. These demands might be overtaxing a young musician on multiple levels and result in increased levels of psychological stress as the student is exposed to higher expectations in a more competitive environment. Additionally, the difficulty of the played material might introduce a new set of challenges on a physical and neurological level. Learning complex materials with an insufficient technical foundation can lead to discrepancies between the required motor movements and the available skill, which can lead to ineffective adaptations (Sadnicka et al., 2018). These negative adaptations can develop on a physical level, i.e., additional muscles are recruited to complete the task leading to excessive tension, which, with sustained repetitions can lead to neurological changes and can pose a risk for MFD (Sadnicka et al., 2018).

In summary, the early learning environment can have a significant and enduring influence on a musician’s career (Waters, 2020a). The characteristics of the environment (e.g., the atmosphere in the lessons and provided psychological safety) and the content of the teaching itself (e.g., attention to technique, appropriate learning trajectory) can condition a young student not just on a technical level, but it can influence the belief system around playing and performance as well (Lakes, 2005; Patston, 2014). It became clear from all three studies (S1; S2.1; S3) that at least a portion of musicians with MFD had a dysfunctional learning environment from the beginning of their studies, and they entered higher education with already established problems, both in the technical and psychological level.

Professional education

For young musicians who wish to pursue a performance career, the next step is to enter specialised courses, such as conservatoires. This transition proves to be a challenging one for most: the environment is competitive given that the students are specifically selected based on merit, and the performance demands are increasing which leads to an escalation in stress-related psychological problems in many students (Bamberger, 1982; Zander et al., 2010). As the previous sections discussed, at least a portion of the musicians with MFD entered this stage of their career with already established negative mental, cognitive, and behavioural habits: potential hypervigilance, anxiety, and perfectionism might have been present due to the lack of experienced psychological safety in their homes and early education, and they potentially had inefficient, compensatory movement strategies when playing due to the inaccurately established playing technique and/or the swift advancement on the instrument. Moreover, their perfectionistic attempts to meet the demands of the authority figures to gain acceptance possibly resulted in overwork or study addiction (Lawendowski et al., 2020). All three studies provided rich data regarding this period in the musicians' lives, especially S1, where the narratives were centred around the educational experiences during this stage. Various influences were listed from personal issues to problems relating to the method or quality of the received teaching and stressors stemming from the environment; these will be systematically discussed in the next paragraphs starting from the broader, institutional context and the traditions in higher education, and honing into the personal relationships, pedagogical approaches, and their potential influence on motor acquisition and performance, and their contribution to the development of MFD.

Specialised education varies greatly from country to country, and it is organised differently in terms of the starting age, length of the course, and content. While in most countries professionalisation happens at a college level (i.e., over the age of 18), there are places where institutions, carrying the name "conservatoires", educate young musicians professionally from the age of 11-14 (Delfrati, 2021; Pásztor, 2021). Thus, some participants began their professional education at a very young age (including those who attended traditional college courses early) while others started focusing on instrumental playing during their college years. However, regardless of the age range of the students participating in professional education, the institutions seem to operate alongside similar traditions and frameworks, placing the individual instrumental lessons on the top of the hierarchy above all the other subjects with the goal of producing high-achieving professional musicians.

To understand the characteristics of this individual tuition and its influence on the development of MFD, it is important to start from the context: the institutions themselves, given that the value system, expectations, and traditions embedded on an institutional level have a significant impact on how the social actors function within the framework (Duffy, 2013; Ford, 2010; Papageorgi et al., 2010; Perkins, 2013). There is a growing body of research exploring the learning cultures and practices of conservatoires and other music programs in higher education. It is commonly understood that the institutional structure, curriculum, and tuition taking place are often driven by tradition (Jørgensen, 2000; Perkins, 2013) followed by the social actors in the system habitually (Duffy, 2013; Ford, 2010). As observed in other performing arts settings, such as dance, these pedagogical heritages are often transferred "uncritically from generation to generation" (Lakes, 2005, p. 4.), and they are operating in relative isolation and secrecy, without any external quality control (Gaunt, 2011; Jørgensen, 2000; Kemp, 2013). Conservatoires have been called "secret gardens" (Burt

& Mills, 2006, as cited by Perkins, 2013, p. 196) engaging in a “culture of concealment” (Carey & Grant, 2015, p. 6); a system which is upheld and endorsed by both the institutions and its teachers. Most teachers seem satisfied with this traditional educational system, and seem to be reluctant to embrace change, even if it is informed by pedagogical research (Duffy, 2013), and are often sceptical towards research being undertaken in this area, especially if its goal is to examine the outcome of their teaching methods (Carey & Grant, 2015; Gaunt, 2011).

Perkins (2013) observed some of the characteristics of these unique learning cultures and identified four important characteristics which outline the environment: the central role of performing specialism, creating professional social networks, a strong hierarchical structure among students, and securing vocational positions. This clearly shows that a considerable amount of professional pressure and competition is already present at this level (Demirbatir, 2015), which might have an impact on individuals who are psychologically vulnerable (Zander et al., 2010). Moreover, the hierarchical structure among the students, which is based on achieved successes or perceived talent is reinforced by the teachers who grant opportunities to selected students and show favouritism (Demirbatir, 2015; Perkins, 2013), can create psychological pressure on all, especially those who have strong perfectionist tendencies (Waters, 2020a; Zander et al., 2010).

It is clear that in these learning cultures, the teachers have a central role in enabling these characteristics and have a profound impact on the students. While individual learning - the core of instrumental learning in higher education - is generally identified as an effective means for educating professional musicians (Carey & Grant, 2015; Gaunt, 2008; Gaunt, 2009), there are frequent criticisms of some aspects of the system, and calls for change (Demirbatir, 2015; Duffy, 2013; McWilliam et al., 2006). The established way of teaching in these institutions follows a master-apprentice model: a pronounced asymmetrical hierarchy which enables the authority figure, the teacher, to exercise profound control over the education of their students, and subsequently, the educational outcome (Gaunt, 2011; Haddon, 2009; Hyry-Beihammner, 2010; Kemp, 1996; Nerland, 2007). Apart from the content of the teaching itself, there are other interpersonal factors which can immensely influence this outcome, such as the communication between student and teacher, the created atmosphere, and other qualities of the learning space (Gaunt, 2011; Jørgensen, 2000); these contextual factors have further implications for the mental and physical health of the student as well (Waters, 2020a). How these qualities are being perceived depends on the student's personality and previous experiences (Burwell, 2017), and their subjective impression of the locus of control (Schmidt & Stephans, 1991); however, some experiences are objectively and undoubtedly traumatic and diminish the sense of autonomy and dignity in the student.

Musicians who were later affected by MFD reported such experiences which had a profoundly negative impact on them in this crucial stage of their lives (S1; S2.1). The most serious reports regarding this relationship were claims of sexual abuse; a crime against students which has serious mental (Chen et al., 2010) and physical (Paras et al., 2009) health implications and unfortunately, seems to happen with alarming frequency in music institutions. Pace (2013; 2014; 2015) indexed and described no less than 34 newspaper articles about various sexual abuse cases within music educational settings in the past decade in the United Kingdom only, including allegations against successful professors of renowned institutions, such as the Royal Northern College of Music, the Royal College of Music, and the Purcell School. Unfortunately, victims of sexual abuse rarely come forward immediately after the event for multiple reasons. Often, they do not believe that the formal social system or institution would believe or help them, and additionally, they fear re-traumatisation, or retaliation from the abuser (Patterson et al., 2009). In an educational setting, where the preparator is the authority figure, i.e., the instrumental teacher (as reported in S2) who is responsible for the professional development of the student, the fear of retaliation might bear even more weight. As Perkins (2013) observed, teachers, who are often outstandingly successful musicians themselves, are frequently in the position to help their students to secure vocational positions; therefore, they have some influence over the student's professional career. In many reported cases of sexual abuse in higher music institutions, the preparators fully exploited this fact and used "flattery and promises to help the students' careers" (Pace, 2013) for personal sexual gains.

Apart from these extremely serious allegations of sexual abuse, reports from all studies point towards other types of harassment, bullying, belittling, and humiliation from instrumental teachers, often as a response to mistakes or a "less than perfect" performance (S1; S2.1; S3). It seems that this behaviour on the teachers' part was often fuelled by the idea that it will somehow motivate the student to engage more with the material and the instructions and that it will enhance learning. However, the context often carries more meaning than the content itself (Gruhn, 2004); as Lakes (2005) explains, in educational settings "how a subject matter is conveyed can be more powerful than its what—the content" (p. 4). In other words, the delivery of the information has a more significant impact on the learning outcome than the material itself. Therefore, it is likely that this educational experience aggravated negative psychological states in the musicians who were later affected by MFD, rather than further their development.

Moreover, the parameters of acceptable behaviour or performance were not always made clear for the musicians in the studies (S1; S2.1). As one example presented in S1, the participant's teacher expected them to sing a specific pitch without contextual help and any previous indications that the task will be presented. The exercise might be acceptable for a student with perfect pitch[15] but it is not achievable for someone without the skill, nor is it a necessity for playing an instrument. Following the student's failure at the task, the lesson was terminated, without any indication of what the task was about or how they could improve their pitch recognition to meet the expectations of the teacher. Other, less specific expectations included winning a competition or an audition – an outcome which is clearly not in the student's control - or performing challenging materials without being taught the required technique or skillset.

These experiences are likely to be anxiety-provoking, especially if we consider that the musicians at this point were largely dependent on this single teacher who was responsible for their development and have a significant impact on their future careers (Gaunt, 2011; Perkins, 2013; Presland, 2005). This influence manifests itself not only in the development of performance skills but has further implications for the student's future beliefs about their ability and their self-efficacy (McPherson et al., 2022); the teachers' negative, powerful judgements can "become part of a student's self-conception" (Lakes, 2005, p. 5.). Furthermore, the relationship with the instrumental teacher can impact access to professional networking and securing future jobs (Perkins, 2013). Therefore, it is likely that the teachers' behaviours and opinions had a tremendous impact on the young musicians, much like a parent's influence in early rearing. Instrumental teaching can be viewed as musical parenting (Creech & Hallam, 2003), which has an abiding influence on the musician's attitudes to playing and performance. In fact, when it comes to performance-specific domains, the teachers' impact might surpass the parents' expectations: Madigan et al. (2019), when exploring the development of perfectionism in junior athletes, found that the coaches' pressure had a more significant long-term impact than the parents' pressure. In conclusion, the teacher's attitudes, expectations, requirements, and the way they communicate them,

[15] Perfect pitch is the ability to recognise or produce an absolute pitch without a reference point.

possibly shape the young musicians' performance-related behaviours and relationship to their instruments and musicianship. In the case of musicians with MFD, this influence was most often negative, aggravating anxiety, perfectionism, low self-esteem, low self-efficacy, rumination, and in general, increasing levels of stress and decreasing psychological safety.

The lack of safety induces stress in the individual which has very specific physiological consequences: the increased levels of muscular tension in response to stressful stimuli and situations is a well-document fact (Larsson et al., 1995; Laursen et al, 2002; Van Loon et al., 2001). These elevated levels of tension can appear in the postural (antigravitational) muscles that carry static loads, such as the muscles supporting the shoulders, and have a subsequent effect on the movement of the arms. In the presence of mental stress, the tension in the shoulder muscles increases significantly (Larsson et al., 1995) and this relationship has been found so predictable and profound that EMG measurements of the Trapezius muscle have been suggested as a reliable method to measure mental stress levels (Wijsman et al., 2013). Muscular stress responses are also observed in the neck extensor muscles (Laursen et al., 2002) and are associated with "forward head posture" (Tanveer et al., 2018) which has serious physiological consequences, including neck and shoulder pain (Neupane et al., 2017), myofascial pain (Sun et al., 2014), temporomandibular disorders (Lee et al., 1995), and even nerve damage (Neupane et al., 2017).

Similar activations can be detected in muscles actively contributing to the movement. Laursen et al. (2002) found significantly increased muscular tension in the forearm muscles of participants when they completed a stress-inducing computer task (typing and using a computer mouse), and these levels of tension seem to increase with the speed and required precision of the task (Laursen et al., 1998). While typing on a computer or performing other repetitive tasks differs from playing an instrument in terms of the variety of the movements and the lack of auditory feedback, they require similarly fine motor movements, carried out in a relatively static posture. Thus, it can be hypothesised that similar activation takes place when performing on an instrument in a highly stressful environment.

The increased muscular activity might also be not only a direct response to stress but a subconscious attempt to complete the task in a satisfactory manner: under psychological stress, limb stiffness (co-contraction of agonist and antagonist muscles) increases which reduces the degrees of freedom at the joints in order to stabilise the movement and gain better control over it (van Loon et al., 2001). While this might be a good strategy to ensure the accuracy of the trial at hand, it is likely that it is not sustainable: if the approach becomes habitual during learning motor patterns and is repeated excessively over the course of years, the individual might overstrain the muscles in question and develop an overuse injury. The inefficiency of the approach lies in employing excessive muscle tension, even in regions which have no direct impact on the task, e.g., the neck (Laursen et al., 2002; Tanveer et al., 2018) which can prompt a static posture and strain exclusively a specific group of muscles, increasing the possibility of injury (Steinmetz et al., 2010). Considering that some participants (S1) might have had inefficient playing technique when starting their professional education, these stress-induced muscular tensions might lead to even more serious consequences, restricting the available technical ability even further. Moreover, the aforementioned co-contraction of agonist and antagonist muscles is a frequently observed symptom of MFD (Sussman, 2015; Wilson et al., 1993), which might indicate that this motor activation developed from a faulty technique which was repeated unchallenged by the teachers (S1; S2.1; S3) in the attempt to better it under significant psychological stress.

Even if the musician is able to sustain this unhealthy and stressed movement behaviour, it is not desirable when it is applied to the complex and variable movement patterns required to play an instrument. These sophisticated and intricate motor sequences can be impaired if the possible available variations in the movement (i.e., degrees of freedom) are reduced due to the stressful conditions in which they are performed (van Loon et al., 2001). Instrumental techniques which require speed or rapid change between positions (e.g., double tonguing in wind instruments or changing strings in string instruments) might be especially vulnerable to locally increased tension. The inability to perform at the desired speed or acquire the required dexterity and flexibility presented a problem for many participants in S1. It is possible that these technical difficulties were due to the psychologically induced stress which translated into such muscular activation which hindered the musicians' ability to fulfil the task requirements.

The lack of support in terms of biomechanics and the lack of understanding of the psychological origins of the restricted motor movements in addition to the heightened levels of perfectionism can lead to increased levels of practice, which was frequently reported in both S1 and S2. These excessive, and sometimes even obsessive practice regiments (e.g., one participant in S1 reported 8-10 hours of practice per day without pauses) can be understood as repeated attempts to perfect the performance and as the manifestations of insecurity and the lack of feelings of competence, triggered by external and internal feedback. This type of overwork in musicians was described as a behavioural addiction or study addiction and has severe consequences on wellbeing, physical health, and sleep quality and has a strong positive relationship to the experienced stress (Lawendowski et al., 2020). Interestingly, the behaviour does not seem to improve academic achievement, in fact, it is negatively associated with the immediate performance (Lawendowski et al., 2020). Thus, in a vicious circle, the experience might prompt further increases in the amount of practice, given that it seems to be the most obvious tool to better one's performance. Moreover, musicians in S1 expressed a rather distorted view of their achievements: they frequently dismissed the interviewer's positive comments on their successes and highlighted the occasions when they did not meet external or internal expectations. This attitude is unsurprising, given that perfectionist tendencies are associated with lower levels of goal satisfaction (Mor et al., 1995), and clearly shows the participants' ongoing and somewhat obsessive needs to better themselves.

It is clear from the literature that unreasonable practice regimens lead to serious physical, and neurological consequences as well (Altenmüller et al., 2014; Chopyk, 2021; Lawendowski et al., 2020). The physical implications of overuse, i.e., musculoskeletal injuries and pain are clearly demonstrated in the literature (Baadjou, 2018; Bird, 2013; Blanco-Piñeiro et al., 2017; Kok et al., 2016). Both pain and fatigue stemming from overuse can modify movement behaviour (Sterling et al., 2001) by decreasing the muscles' capability to fulfil the requirements associated with the task (Sadnicka et al., 2018), and have been associated with the onset of MFD (Altenmüller et al., 2014). Grünewald (2007) and Stein et al. (2016) agree that this relationship is due to the distorted feedback arriving in the brain and the resulting deteriorating predictive control of the Central Nervous System (CNS). The movements performed in a fatigued state supply inaccurate information to the CNS of the necessary velocity, force, and position of the body parts and muscles participating in the movement (Grünewald, 2007), which becomes inappropriate in a rested state. This feedback loop also produces discrepancies between the expected and realised movement, and with time, the process can contribute to the deterioration of the CNS's ability to predict future positions, resulting in inappropriate use of the encoded elements of the motor sequence, leading to the development of MFD (Stein et al., 2016).

Repeated inefficient motor behaviour can also be prompted by the received feedback and cognitive strategies (Wulf & Lewthwaite, 2016). Participants from S1 were taught with excessive focus on their motor movements with little emphasis on musicality or expressivity, and this controlling behaviour became habitual in many participants as a tool to achieve immaculate performances (S2.1). Chopyk (2021) argues that in these pedagogical strategies "execution supersedes meaning" (p. 46) and describes their own experience with this internal focus before the onset of their MFD:

> I was no longer attempting to play music the way I wanted it to sound. Instead, I was executing meaningless instructions from the musical notation. Being someone with a natural musical voice, this was a subversion of one of the most powerful forces in my arsenal as a performer. (p. 45)

Variations of this type of cognitive behaviour are described in the literature as "reinvestment" or "internal focus of attention", and it has been linked to "choking under pressure" in sports, ineffective motor learning and performance (Wulf, 2013), and MFD as well (Altenmüller et al., 2014). How the individual thinks about the movement and the target of their attentional focus have a surprisingly significant impact on the quality of the movement (Wulf, 2013; Wulf & Lewthwaite, 2016). Employing an internal focus of attention leads to unnecessary tension in the antagonist of the engaged muscles (Lohse et al., 2010; Lohse et al., 2011; Zachry et al., 2005) resulting in a less efficient and sustainable movement behaviour which is likely to lead to fatigue sooner than a balanced, and efficient movement. It also reduces accuracy and precision and even diminishes musical expression (Mornell & Wulf, 2019).

Despite its clear disadvantages, participants seemed to be relying on this cognitive strategy both in practice and performance (S1; S2.1). One reason for this is the aforementioned pedagogical strategy: the teachers of the participants (S1) actively encouraged them to pay attention to small, technical details of the motor movement to achieve flawless performance. Additionally, in a psychologically unsafe environment, where the parameters of acceptable performance are the errorless execution of the movements and mistakes result in humiliation, belittling, and other types of emotional abuse, the role of anxiety in guiding the focus cannot be overlooked. Recruiting all the available resources (including increased concentration on the task) to present a flawless performance and avoid negative feedback is an adaptive response at the moment, even if it is damaging in the long run.

In summary, there are various factors characterising the professional educational experience of musicians who were later affected by MFD. The elements in this partially hidden multifactorial system trigger, influence, and regulate each other, resulting in the profile frequently associated with musicians with MFD (e.g., perfectionist, anxious, and obsessive). This characterisation of affected musicians might be accurate but without the contextual information, it can place the full responsibility on the musicians themselves by critiquing their obsessive behaviours and psychological tendencies. In reality, many of these characteristics seem to be the product of their adaptive responses to the demands of their social contexts.

The psychologically vulnerable, potentially hyper-alert, perfectionist, and anxious young musicians enter an environment which is competitive and stress-inducing by nature, led by a strong authoritative control, and has strongly established hierarchies. For many, their primary teacher, who exercises a profound control over their educational outcomes and can potentially influence their future employment, aggravates their maladaptive perfectionism and deepens their anxiety by placing unattainable and sometimes unexplained demands on them, using denigrating and demeaning comments, and in some cases, various forms of abuse. Moreover, they do not provide the required professional support and use teaching strategies which are damaging the process of movement acquisition and performance.

The consequences are manifold. The students need to develop strategies to cope with the situation, and many of these strategies are destructive themselves. More intense levels of self-directed perfectionism appear in order to avoid further hurtful criticism. Conscious control of the movement (i.e., reinvestment or internal attentional focus) is developed to avoid making mistakes, and obsessive, excessive practice strategies are employed to perfect performance. The failure to achieve the desired goal of pleasing the teacher or meet one self's high expectations results in anxiety, mistake rumination, anxiety, low self-esteem, insecurity, harsh self-criticism, sleep problems and in some, substance abuse, and has somatic consequences, such as restricted movement behaviour and excessive muscular tension. There is no doubt that musicians with MFD experience these factors to varying degrees, yet it seems that most of them exit their professional education and enter their professional careers in a psychologically, physically, and behaviourally fragile state.

8. 2. 3. Professional life

Most musicians who are affected by MFD spend many years in professional working environments before experiencing the symptoms, given that the average age of the onset is the mid-30s (Conti et al., 2008). The findings of S3 align with this estimation perfectly: the average was 35.57 years; however, the sample in S1 seems to slightly differ from this model. Seven of the 15 participants in S1 developed MFD during or immediately after finishing their studies and apart from occasional paid work, did not have prolonged experience in the professional environment. The participants in S2 shared some of their clients' stories regarding working professionally, but in S3, there were no questions specifically targeting this phase of the musicians' lives, given that the survey was built on the most pronounced findings of the interview studies (S1; S2.1). Therefore, the argument in this section is mainly built on the narrative of eight participants in S1 and the practitioners in S2, and the literature exploring professional playing environments, such as orchestras.

Transitioning from student to professional is a challenging process for most musicians (Creech et al., 2008). To successfully negotiate this transition, both external and internal factors need to be in place: the individual needs support from the teachers and institutions, and at the same time, they must develop adaptive coping strategies, self-efficacy, and self-belief (MacNamara et al., 2006). The narratives of musicians with MFD unveil yet another phase in this developmental trajectory where they did not feel supported and confident: many were lacking parental and educational support and strong self-belief (S1). The negative experiences with the received education and the judgments of the authority figures served as a foundation for the self-conception of these musicians while attempting to meet the even greater challenges of the professional industry.

The most often reported characteristic of years following professional education was overwork in the narratives of the affected musicians (S1; S2.1). Participants from S1 increased their practice in order to prepare for auditions and concerts, but at the same time, took on other responsibilities for financial reasons, such as teaching. As an example, one participant reported having the guitar in their hands 8-10 hours a day while teaching, practising, and performing in the evenings. Another pianist participant had to take a long train ride to work and reported practising finger patterns on the train tables because of their limited time in the practice room. The process of establishing and developing one's career can be stress-inducing: when auditioning for professional playing positions, the stakes are even higher than during education. While a mistake at a lesson or evaluation at the conservatoire might have resulted in negative feedback, at an audition, the quality of a single solo performance has long-term consequences which might result in severe anxiety (Kegelaers et al., 2022).

Other participants (S1) embarked on a journey to finally "fix" their technical problems to meet the perceived expectations of the professional environment, while others complained about the psychosocial stress stemming from their relationship with their peers or superiors, such as conductors or band leaders. One participant (S1) reported that their conductor was disappointed when they learned that they were female after they won a blind audition and had a sexist and humiliating approach to them at each rehearsal. Chopyk (2021), in their memoir about developing embouchure dystonia, identifies the negative attitude of a work colleague and the stressful environment as the direct trigger of the onset of their symptoms. Naturally, these situations result in heightened levels of stress and pressure on the possibly already psychologically and physically vulnerable musicians.

The limited research into the professional musicians' psychosocial environment paints a rather negative picture: Détári et al. (2020) compared these circumstances to the general workforce and found that musicians face higher demands but receive less support and feel less rewarded (both in terms of acknowledgement and financial compensation) than other professions. These characteristics were linked to musculoskeletal injuries and pain Jacukowicz (2016), mental health issues, and increased stress (Hasson et al., 2009). While there is little available data obtained by the studies about this particular phase in the musicians' lives, considering the previously experienced difficulties, it is reasonable to hypothesise that these circumstances aggravated their anxiety, perfectionism, and maladaptive coping strategies.

8. 2. 4. Events before the onset

The data provided several reports of sudden, stress-inducing events preceding the onset (S1; S2.1), which happened either on a professional or a personal level. Examples of these are the death of a close relative, divorce, change of instruments, teachers, or technique, becoming unemployed or starting to work in a new environment, moreover, accidents which left the musicians with physical injuries. These events have been reported by 35% of the sample presented by Schmidt et al. (2013) and are also mentioned in the qualitative research of Schneider et al. (2021). These experiences were described as highly stress-inducing and proved to be difficult to cope with on an emotional and psychological level (S1). However, the musicians in S1 and S2.1 did not modify their playing or performance behaviour to adapt to these challenging situations, in some cases, they even increased their involvement with practice and performance (S1).

Other reported events (S1; S2.1) had clear biomechanical implications, such as physical injury, attempts to change an established technique in response to external or internal pressure, or changing to an instrument which differed in size, weight, or in any other way. As an example, one participant (S1) experienced the first symptoms after changing to a smaller mouthpiece on the horn to achieve a louder and brighter sound quality. These precursors, especially if they are linked to the spatial parameters of the task, have been identified as triggering factors by Sadnicka et al. (2016).

However, as one participant in S2 pointed out, these changes and events cannot be viewed as the sole origin of the onset. They are more likely to be the final step in a long process of physical, mental, and behavioural deterioration and cumulative stress and traumatic experiences, which are possibly also furthered by the age-related decline of motor function (Sadnicka et al., 2016).

8. 2. 5. The onset of MFD

There are various ways MFD symptoms can appear: for some, it is a slow and seemingly unstoppable deterioration of the instrumental technique, for others, it is a rapid and dramatic change in the motor skills (S1; S2). Either way, the musician is left with reduced control over their motor movements and as a result, their ability to play on the level they are accustomed to (Altenmüller & Jabusch, 2009; Conti et al, 2008; Sussman, 2015). In classical music performance, such a high level of precision is needed that even the smallest deterioration can cause an inability to participate in the work at the usual level (Altenmüller & McPherson, 2007; Sadnicka et al., 2016); therefore, the onset is arguably an exceptionally traumatic experience for the musician (Toner et al., 2016). Acquiring the exceptional skillset required to be a professional musician takes decades of dedicated practice (Ericsson, 2002; Ericsson et al., 1993), and during this process, the musician's playing ability becomes not only the source of their income, but their identity (Sanders, 1998), and for many, the basis for their social connections (Guptill, 2012). Thus, experiencing problems with their movement control puts them in a difficult position on a psychological, emotional, social, and economic level (Toner et al., 2016; Zaza et al., 1998), and the fact that there are no reliable rehabilitation strategies makes the situation even more challenging.

As discussed in detail in the previous section, the onset is not a sudden, unexpected event but a result of a long period of deterioration in mental and physical health and behaviours. Yet, for the musician, given the lack of information, it is unforeseen and unexplained, and it has a very significant and negative impact on their mental health (Toner et al, 2016). The peculiar task-specific nature of the condition, and often, the lack of physical pain or injury which would explain the dysfunction, might confuse the musician, and the habitual response to technical difficulties - more practice – does not rehabilitate the symptoms. As Chopyk describes this period in their memoir: "I practised more and more. The rational thought of practising to fix a problem turned into a frantic whirlwind of attempts to regain ability (p. 32).

The consequences are manifold. Musicians' identities are often closely linked to their ability to play (Sanders, 1998; Toner et al., 2016) and interruptions or malfunctions can threaten their "embodied sense of self" (Toner et al., 2016, p. 53). It also engenders the performer's livelihood given that becoming a professional musician requires excessive training, other skillsets are rarely developed, which leaves the musician to rely on their playing skills as a source of income. The question of finances can lead to further obstacles in terms of rehabilitation, considering that some of the privately provided treatment strategies place a substantial financial burden on the musician. The ethical implications of this will be further discussed in the following chapter, in Section 9.1.5., “Ethical considerations”.

Moreover, the full impact of the onset of the symptoms cannot be completely understood by focusing on the individual experiencing them. The musician is embedded in a social context which is constructed fundamentally on the basis of instrumental skill. A musician cannot participate in a professional assignment without the reliable ability to produce the required output. Musicians who cannot fulfil the requirements due to injury, often report marginalisation, losing or giving up jobs, and a threat of occupational deprivation (Rickert et al., 2014a; Rickert et al., 2014b; Guptill, 2012), which, in the light of the poor treatment outcomes in MFD, might become even more serious and career-threatening. Moreover, personal social relationships (friendships and acquaintances) are also often tied to the professional environment, and communicating the problem often proved difficult for the participants in S1. Reporting injuries might result in becoming stigmatised (Ackermann, 2017) and replaced. In other words, the links which tie the musician to their social environment are at least partially dependent on their skill and are severed by MFD.

In summary, the onset is a severe trauma which impacts the musician on a psychological, behavioural, and social level. Considering the existing maladaptive psychological traits, self-beliefs, and negative coping strategies which are possibly present in this population, this traumatic event might be devastating.

Chapter 9. Implications for treatment

This chapter discusses the new model's implications for treatment strategies, corresponding to the second goal of the research, identified in Chapter 1., Section 1.1. The material is approximately organised based on the structure presented in S2.2 in Chapter 6., with additional conclusions drawn from the rest of the findings and is presented in the following subsections: 9.1. Mindset, identity, and psychological support, 9.2. Constructing the environment, 9.3. Cognition and attentional focus, and 9.4. Biomechanics, self-efficacy, and practice strategies. Moreover, in the last subsections, the ethical considerations of MFD treatment are discussed (9.5). The chapter is a continuation of the timeline presented in the previous one, resuming the narrative from the point of the onset of the condition.

Once a musician finds themselves unable to perform on their instrument at the level they are accustomed to due to MFD, there are several potential steps they can take. Their decision, however, is likely to be influenced by their psychological and emotional states and their circumstances. As touched on in the previous section, their ability is closely linked to their identity (Sanders, 1998; Zaza et al., 1998) and embodied sense of self (Toner et al., 2016), thus, experiencing a deterioration in the skill has traumatic consequences. As Chopyk (2021) articulates when describing the onset of their embouchure dystonia: "whoever I thought I was, began to disintegrate. When the illusion of identity vanishes, the pain of loss is severe" (p. 10). Feelings of shame and guilt might also accompany the motor symptoms of the disorder (Altenmüller, 2021); musicians in S1 expressed that they blamed themselves for creating the situation which enabled and furthered the onset of the condition. Furthermore, for most, performing serves as the primary source of income, and any disturbances can lead to financial insecurity which can aggravate the negative mental state (Kopasker et al., 2018).

The professional environment musicians are embedded in oftentimes has a negative attitude towards injuries (Ackermann, 2017; Rickert et al., 2014a; Rickert et al., 2014b) which can manifest itself in the threat of occupational deprivation and marginalisation (Guptill, 2012). As a response, musicians tend to downplay or conceal their difficulties (Rickert et al., 2014a), which can generate further barriers to receiving potential support. This problem is complicated even further for musicians with MFD. There is little awareness of the condition in general; as an example, Konaka & Mochizuki (2015) found that in their sample of 480 tertiary music students, only 29% had some knowledge of the condition, while 1.25% suffered from it. As a result of this lack of awareness, in addition to the feelings of shame, and fear of losing one's position or professional standing, some might not even seek help at all and attempt to resolve their issues on their own (Conti et al., 2008).

For those who are seeing help, there are several potential outcomes. Given that the condition is not widely known among medical professionals, and is difficult to diagnose, musicians might get misdiagnosed and receive inappropriate treatment (Rosset-Llobet et al., 2009; Sussman, 2015). Apart from receiving an incorrect diagnosis for MFD, getting a false positive diagnosis is also a dangerous possibility (Altenmüller, 2021). There are other conditions which can cause dystonia-like symptoms, such as serious neurological degenerative disorders, such as Parkinson's disease (Altenmüller, 2021), or there might be a more physical and treatable problem present. As an example, a participant in S2 recalled a client who was diagnosed with MFD while in reality, they had fractures in their jaw following a fall which led to pressure on a nerve, producing dystonia-like tremors and loss of control in particular jaw positions.

For those who obtain a correct diagnosis, there are still no straightforward solutions, and they might receive unsuitable care. The relative success of the most often used strategy, Botulinum Toxin injections to the affected muscles, is highly dependent on the precision: as

Molloy et al., (2002) found in the case of focal dystonias, the injections following a visual examination only reach the target muscle in 37% of the cases. Moreover, even when the injections are EMG guided, positive results are not guaranteed (Grünewald, 2007) due to the lack of specialised expertise. Before taking this approach, the individual's situation must also be assessed as the example of one multi-instrumentalist pit musician demonstrates: after reporting problems with their flute playing, they received Botulinum Toxin injections in their facial muscles. Following the treatment, they were unable to play the rest of their instruments (clarinet, saxophone, and oboe) due to the paralysed facial muscle, and lost all their work and income as a result (B. Schaffel, personal communication, August 17, 2021).

Even if the musician manages to receive a diagnosis and medical care from a professional who has the necessary expertise, the outcome of the treatment is dubious. The vast majority of musicians with the disorder do not regain their ability completely, even if some improvement is often reported (Altenmüller & Jabusch, 2010; Enke & Poskey, 2018). The most promising approaches are various versions of behavioural therapy (Altenmüller, 2021; Altenmüller & Jabusch, 2010; Van Vugt et al., 2014), such as neuromuscular re-education programs, slow practice, and splint therapies (Berque et al., 2013; Byl et al., 2003; Candia et al., 1999; Chamagne, 2003; Tubiana, 2003; Tubiana & Chamagne, 2000). These approaches have no side effects and target the disrupted movement patterns directly by using various somatic exercises; however, the outcome of these practices is still not satisfactory (Enke & Poskey, 2018).

The reason for this is partially the incomplete understanding of the pathophysiology (Altenmüller & Jabusch, 2009; Sussman, 2015) and the large variety of the displayed symptoms, but another important factor might be the narrow perspective from which the condition is approached. While the multifactorial nature of the disorder is widely acknowledged and psychological traits have been suggested to be included in the pathophysiology, there are no guidelines in the literature on how to approach the resulting non-motor symptoms in practice. The unspecified pieces of advice presented in the literature are frequent: according to Tubiana (2000) “being aware of the psychological profile of the patient remains important as it certainly influences the problem and affects the development of the treatment programme that will be instituted” (p. 338) and Chamagne (2003) recommends including psychotherapy into the treatment. However, there are no suggestions about how these vague instructions should be followed or any established protocol in place.

Apart from frequently reported maladaptive psychological traits, such as anxiety and perfectionism (Enders et al., 2011; Jabusch et al., 2004; Jabusch & Altenmüller, 2004) the findings of S1, S2, and S3 show that at least a proportion of the musicians with MFD might have well-established and dysfunctional cognitive and behavioural habits due to negative experiences with their rearing, and educational and professional experiences, some of which are directly related to the ability they are trying to recover. These include maladaptive practice and coping strategies, negative self-concepts concerning their ability and “talent”, and inefficiency in the biomechanical quality of the original technique itself. The theory of implicit body memory (Fuchs, 2003; Jansen, 2012) states that prior experiences with performing a movement influence subsequent repetition, not just in terms of the motor function itself but the simultaneously occurring situational stimuli. In other words, if a movement behaviour is repeated under stress and/or with a negative connotation, these characteristics will impact the recall and performance of the skill; as Byl et al. (2000) describe the phenomenon, “the hand remembers something about the target task” (pp. 289-290). Thus, musicians with MFD might carry adverse implicit body memories imprinted during their education (S1; S2.1; S3), but also the accumulated somatic experience of the onset, and living with the symptoms of MFD.

Consequently, the musicians entering any kind of therapeutic environment are potentially experiencing a multitude of problems apart from their visible physical symptoms which can be barriers to rehabilitation and call for a holistic treatment approach. Attending to the person as a whole, acknowledging the impact of the external influences in their lives, and considering their psychological functioning and behaviours carry extreme importance in the rehabilitation from MFD. Opposing many other medical procedures, such as undergoing surgery or taking a prescribed drug, in the process of regaining control over the deteriorated skill the musician is an active participant (Jabusch & Altenmüller, 2006). Overlooking the fact that the outcome of the treatment is largely dependent on the individual’s practice and characterising the musician as a passive patient is unhelpful because it fails to exploit the musician’s knowledge, expertise, and work as a resource. In order to enhance the therapeutic approaches, the first step is to ensure high-quality, self-led individual practice between any sessions or appointments, and to achieve this, attending to the musician’s psychological, cognitive, and behavioural issues and needs is crucial.

The ability to implement this support is highly dependent on the provider. Medical practices might be well equipped with the necessary tools for pharmaceutical interventions but less prepared to provide or be open to a multidisciplinary treatment (Fava & Sonino, 2007; Thrall, 2005). Moreover, the available time for each patient/client might be limited and some services are not accessible for repeated sessions to supervise the rehabilitation process. In these cases, the musician should be directed towards additional resources whenever possible to attend to their non-motor symptoms as well as receive advice on how to approach their practice to rehabilitate their affected movements. However, given the complexity of the problem at hand, and the need to approach it in a holistic manner, frequent therapy sessions might be more suitable. Many behavioural re-education programs which are taking place in private institutions or physiotherapy practices (Berque et al., 2013; Enke & Poskey, 2018) and private sessions provided by musician-practitioners (Chopyk, 2021; Huh, 2020; S2.2) follow this format and administer sessions on a weekly or biweekly frequency.

The findings from S2 clearly show that many practitioners are not only aware of the complexity of the potential problems, but they already established strategies to address them. The need for additional external professional help might still be necessary (e.g., a licenced psychotherapist or a somatic practitioner) depending on the physical or mental state of the musician, since a single practitioner cannot provide all the various types of required support at an expert level. However, some strategies can be easily cultivated and included in any form of therapeutic re-education to enhance the well-being and development of the musician as a result. The following section primarily discusses these recommendations based on the potential needs identified by the studies (S1; S2.1; S3), the established strategies of various practitioners (S2.2), and additional resources about successful individual rehabilitations and practices. When appropriate, additional therapeutic approaches developed for various mental and somatic problems will also be considered as a tool to attend to issues described by the studies (S1; S2; S3).

9. 1. Mindset, identity, and psychological support

There are many fleeting mentions about the desirable mindset which supports the rehabilitation of MFD: Tubiana (2003) concludes that musicians who can “re-evaluate the basic aspects of their playing and some aspects of their professional behaviour” (p. 169) have a better chance of recovery, and Altenmüller (2021) calls for the cultivation of self-care, self-awareness, curiosity, and optimism during the retraining. It is not difficult to see the potential barriers to developing such a mindset during rehabilitation. Musicians who are potentially traumatised by the onset urgently seek a quick solution to their problem to continue their performance career. The unfortunate reality is that the process of improving the playing mechanisms can often take years (S2.2; Tubiana, 2003), but for many, it is a difficult fact to accept. The desperate urgency to eliminate the symptoms as rapidly as possible was described by one of the practitioners (S2.2) as a "forceful must" which can result in psychological distress and increased levels of muscular tension and is a significant barrier to establishing healthy movements. Moreover, the impatience with the pace of the process might prompt the musician to prematurely terminate treatment. Tubiana (2003) reports that 35 of 145 patients in their practice "failed to complete the rehabilitation" (p. 168) due to a lack of motivation and cooperation with the practitioner. The language used in this quote clearly blames the musicians for discontinuing the offered program; however, while the musician undoubtedly carries responsibility for their own health, the provided guidance and how it is communicated might also play a significant role in persuading the musician to persevere. Therefore, the practitioner must communicate the expected length of the treatment and highlight the importance of maintaining motivation and an optimistic outlook throughout the process (Altenmüller, 2021), and find appropriate and individually tailored tools to help the musician to maintain an adaptive mindset.

Practitioners also should be aware that their client's identity and embodied sense of self are severely threatened by the onset (Toner et al., 2016). The decline in the ability to complete the movement sequences necessary for playing can lead to a loss of trust in oneself, and one's body, and raises serious doubt about one's adequacy (Shilling, 2008; Sparkes & Silvennoinen, 1999). Considering the pre-existing insecurity and lack of confidence these musicians might already struggle with (S1; S2.1), the inability to fulfil the task of playing the instrument might result in even more disruption in the sense of self. One potential negative outcome of this situation is that the musician is unable to let go of their established routines in terms of practice and performance and "stubbornly rejects the need to change" (Shilling, 2008, p. 17) since these provide some sense of continuity and the false promise of sustaining the identity (Toner et al., 2016). This rejection might manifest itself in the need to maintain "face" and the refusal to communicate the problem to their peers and superiors and persevering in an unhelpful and unproductive practice regime, but it might impact them in subtler ways, such as unwillingness to let go of deriving their identity from their profession. This rigidity might be a barrier to examining and re-evaluating previous habits which might have been maladaptive (e.g., instrumental technique, practice schedule, work engagements), this act; however, seems an imperative step towards rehabilitation (Schilling, 2008; Toner et al., 2016). As Altenmüller (2021) puts it, musicians need "humanistic and philosophical support", and need to be open to the suggestion that "there is a life without being a performer".

Musicians are not the only professionals who rely on their bodies for fulfilling their role; there are several other occupations where this dependence lies at the foundation of the career and the identity as well. The experience of a disrupted skill due to injury and its impact on identity has been explored in professional dancers (Wainwright et al., 2005) and athletes (Sparkes, 1998; Sparkes & Silvennoinen, 1999), thus the literature provides some recommendations for managing these crises. Toner et al. (2016) explain that if the crisis is met with creative action, it can be a source of growth and development. More specifically, based on Dewey's (1922) pragmatic approach they argue for the development of "intelligent" and "artistic" habits which are flexible instead of trying to restore habitual, "unreflective action" characterised by "end-gaining" (Toner et al., 2016, p. 53). To cultivate such habits, the authors suggest that injured performers should improve their kinaesthetic awareness and cognitive flexibility (Toner et al., 2016); both tools can serve to observe and modify maladaptive habits.

Mental rigidity has been identified as one of the strongest barriers to rehabilitation by one of the practitioners in S2. The inability to let go of old cognitive and behavioural patterns can compromise learning new ones: as Tubiana (2003) notes, the adjustment of performance-related behaviours is essential for the success of the treatment. The literature presents a novel solution for this problem: the model of Psychological Flexibility (PF) (Hayes et al., 1999) provides a theoretical framework for understanding individuals' abilities to develop and/or maintain adaptive cognitive patterns, and the therapeutic modality guided by the model, Acceptance and Commitment Therapy (ACT) presents a practical approach to enhance PF. PF is underpinned by six key concepts, each represented by a psychologically flexible mechanism and its inflexible counterpart (Chelkowska-Zacharewicz & Baran, 2021; Hayes et al., 2012): acceptance/experiential avoidance, contact/lack of contact with the present moment, values/lack of contact with values, committed action/inaction, self as context/self as content, and de-fusion/fusion with thoughts. ACT aims to increase PF by targeting these processes via talk therapy by using functional contextualism[16] (Dionne et al., 2013; Hayes et al., 2012; Ruiz, 2010) as a foundation. The method is a promising approach to addressing chronic illness, depression, and anxiety disorders (Dionne et al., 2013; Ruiz, 2010), and it has also been studied in musicians in relation to Music Performance Anxiety (MPA) (Juncos & de Paiva e Pona, 2018) and more broadly to enhance musician's wellbeing (Chelkowska-Zacharewicz & Baran, 2021) with promising results. Given the underlying key concept of contextualisation, and how the various processes within the model align with the difficulties of musicians with MFD (Altenmüller, 2021; S1; S2.1; S2.2; S3; Tubiana, 2003), both the PF model and the ACT modality might be a useful therapeutic tool in the rehabilitation from MFD.

Musicians with MFD also have to manage potentially pre-existing mental health problems, such as anxiety and perfectionism which are likely to be aggravated by the onset

[16] Functional contextualism examines the behaviour or cognition in its historical and situational context and assesses it based on its usefulness.

and can disrupt their participation in the administered rehabilitation program. As several practitioners noted (S2.2), the need to perform the recommended exercises perfectly (due to internal and perceived external expectations) can increase the musician's anxiety, leading to maladaptive physical, emotional, and behavioural functioning. Study 2.2 provided some practical approaches to decrease the pressing need to control and perform flawlessly, and the resulting anxiety. The used vocabulary when introducing a rehabilitation exercise alongside its goal and success criteria and when evaluating the musician's performance was identified as an important tool for dismantling the client's maladaptive mindset and behaviours. Practitioners stressed that observing the motor output and using it as a source of information rather than imposing expectations on oneself is a cognitive strategy which can be highly effective in loosening perfectionist tendencies. This leads to a dialogue-based debriefing after each trial; a method Patston (2014) suggests for music educators to avoid inducing unrealistic expectations and increase student engagement. Furthermore, when practitioners aim to extrinsically motivate the musician, the content and quality of the praise might also influence the musician's mental state. Accomplishment-based praise might reinforce the rigid and perfectionistic mindset, while effort-based praise can further motivation (Dweck & Master, 2012; Dweck & Molden, 2000). Given that the musician's ability is impacted by the MFD symptoms, and it is not under conscious control, honouring their efforts towards the goal rather than evaluating the output is much more realistic and could enhance self-efficacy and motivation.

Apart from the language used when introducing practical exercises and guiding the musicians through them, communication and language were also used by the practitioners to build rapport with their clients in S2. Many of them highlighted the importance of leading holistic conversations touching on various topics, including the musician's concerns about their future or their recollections of their past. Narrating one's story in order to "make sense" of one's situation is an invaluable tool to support individuals with chronic illnesses (Jacobi & MacLeod, 2011). By articulating the events leading up to the onset of the disorder and reflecting on and moving towards accepting the current situation, the musician might generate meaning and build resilience. McPherson et al. (2001) call this behaviour "taking charge" over one's situation, i.e., developing coping mechanisms to emotionally and physically adjust to the new reality. Moreover, listening to the musician's stories and thoughts can be a source of meaningful information for the therapist (Gidman, 2013; Jagosh et al., 2011), given the high variability in the experiences, background, and displayed symptoms of the musicians; as Charon & Montello (2002) puts it: "the singular case emerges only in the act of narrating it and the duties are incurred by the act of hearing it" (p. 3). In other words, learning about the musicians' narratives can inform the therapists of both their psychological, psychosocial, and somatic needs. A practitioner from S2 provided an example of how this approach works in their practice: the musicians are asked to report in writing about their situation, social support system, illness history, habits and schedules, and meaningful events in their lives, and these topics are further discussed during the sessions. As another practitioner pointed out (S2), the rapport built this way can enhance the engagement with the somatic exercises which follow, increasing the benefits of the lesson.

9. 2. Constructing the environment

The attributes of the environment in which the rehabilitation takes place including the therapeutic relationship seem crucial in terms of the success of the process and the musicians' wellbeing. The construction of this interpersonal space, the established atmosphere and rapport, and the management of the expectations both of the musician and the person leading the session can have further implications for the outcome of the session.

Recurring retraining sessions resemble instrumental lessons: exercises are being taught which are repeated under the supervision of the practitioner, the outcome is evaluated, and further steps are agreed on at the end of the session based on the progress. In the subsequent session, the same material might be repeated to assess the improvement and inform the teaching material. This similarity might provoke the musician to take an analogous approach to previously experienced instrumental lessons. As discussed in great detail in S1, S2, S3, and Chapter 8., musicians with MFD might have adverse experiences with music education due to their teachers' authoritative manner, abuse, and prescribed perfectionism and these experiences might provide a basis for how they are approaching the re-education.

The practitioners from S2 were aware of these dangers and aimed to consciously construct an environment which enables the musicians to have a more open-minded, curious, and relaxed attitude; they identified "safety" as the most important characteristic of the shared space. Establishing the feelings of psychological safety might be challenging with a musician who has adverse experiences; as Fang et al. (2014) observe, the levels of perceived safety are moderated by the individual's experiences with rearing and can modify the social anxiety levels. Extrapolating from this, it is possible that task-specific negative experiences also influence how safe the person feels in the therapeutic environment: repeated exposure to unsafe situations during education or in professional settings in which the individual is ridiculed or humiliated can create fear of subsequent occurrences of the same psychological and emotional harm (Edmondson & Lei, 2014; Seligson & MacPhee, 2004). Given that the feeling of psychological safety is subjective and deeply personal, each musician might need a different approach to ensure their wellbeing during the retraining; however, establishing a welcoming, non-judgmental environment by displaying compassion is generally considered a good tool to enhance the feelings of safety (Latting, 1990; Wanless, 2016).

Consciously disabling the hierarchical and asymmetrical power structure between therapist and musician can also increase the levels of safety in the musician (S2.2). The findings show that musicians were often educated with teacher-led and authoritative teaching methods (S1; S2.1); a phenomenon which is frequently observed in music education both at a beginner (Rostwall & West, 2003) and a conservatoire/college level (Gaunt, 2011; Haddon, 2009; Hyry-Beihammner, 2010). The core of the approach is to fulfil tasks prescribed by the authority figure and get evaluated against their success criteria which can trigger anxiety and perfectionist tendencies (Patston, 2014), especially in the musicians with MFD, who do not have full voluntary control over the motor functions when completing instrumental tasks. Furthermore, applying this concept to MFD rehabilitation might remind the musician of their potentially dysfunctional and ineffective learning experience and trigger psychological distress. To rectify the situation, the therapist should provide guidance within a constructivist framework which allows cooperation between the participants and requires a balanced, symmetrical power structure.

In the past decades, the notion of constructivism has been thoroughly researched in the field of music education (see Webster, 2011, for a comprehensive review), and given the similarities between instrumental lessons and somatic re-education, this literature can serve as a stimulus when working with musicians with MFD. One of the main aims of constructivism in music education (and in education in general) is to inspire the learner to be an active participant in their own learning rather than a passive recipient of the material (Fosnot 2005; Shively, 2015; Webster, 2011). This idea bears huge importance for MFD rehabilitation for many reasons. Musicians with MFD might take a passive stance stemming from their educational and professional experience (i.e., completing the authority figure's instructions without questions), but also from the strong characterisation of MFD as exclusively a medical rather than a professional problem. Thus, the musician might not feel that they have the expertise to contribute to their own rehabilitation. However, while MFD is indeed a neurological problem, due to its task-specific nature, it has strong professional elements, and as discussed previously, requires a more complex solution than pharmaceutical intervention. Therefore, the musician's active participation and instrumental expertise are necessary for the success of the retraining process (Jabusch & Altenmüller, 2006; S2.2) and it needs to be encouraged with the appropriate pedagogical tools, such as dialogue-based communication, open questions, and in general, making room for the musician to develop their own concepts and understanding (Shively, 2015; Webster, 2011). The latter can also support the engagement with the material and the quality of the individual practice, which are essential for the success of the re-education (Tubiana, 2003).

The wide variety of both motor and non-motor symptoms in musicians with MFD also justifies a constructivist approach. Constructivism in education rejects the notion of the absolute truth as an objective entity (Webster, 2011) and sees it as the result of the student's interactions with and responses to the presented material. In other words, the knowledge is constructed as part of a social activity (Shively, 2015); therefore, it is unique for each learner. Using this notion in MFD retraining means that the musician's development is created through constant communication with the therapist and is fundamentally based on their individual symptomatology and interactions with the given instructions and exercises, such as their physical sensations and reactions to stimuli, and the currently attainable capabilities. As a participant in S2.2 noted, the rehabilitation strategy needs to be constantly adjusted based on the musician's feedback and introduced in incremental steps, so that each stage is understood and obtainable. In summary, there is no objective truth about the "correct" way of rehabilitating a musician from MFD, the approach needs to be flexible and based on the musician's needs.

9. 3. Cognition and attentional focus

The role of attentional focus and cognition about the movement (e.g., reinvestment) was a central topic of S2.1 and S2.2. The findings show that musicians who later acquired MFD were taught with an excessive focus on the technical aspect of instrumental playing with much less regard to expression and musicality. Once learned, this cognitive approach was used throughout the musicians' careers to perfect their performance and intensified during stressful situations, such as auditions and concerts. Reinvestment has been also identified as a risk factor in developing MFD by Altenmüller et al. (2014), and it has been excessively discussed in relation to sports dystonias, such as the "yips" and Lost Movement Syndrome (Bennett et al., 2016), stating that it might interfere with already automatised movement pattern.

While the benefits of external focus have been thoroughly discussed in movement acquisition and performance in healthy individuals, much less is known about it in the context of movement disorders (Hunt et al., 2017), such as MFD, especially regarding their treatment. There is some evidence that consciously directing the attentional focus externally has its therapeutic uses when attempting to enhance movement behaviour: a growing number of articles discuss the positive impact of external focus on Parkinson's patients' postural sway (Jazaeri et al., 2018; Wulf et al., 2009), and stroke patients' "functional reach" (Fasoli et al., 2002). Hunt et al. (2017) also argue that the neurocognitive aspect of motor learning should be fully exploited by physiotherapists when attending to patients with musculoskeletal and movement disorders to achieve better treatment outcomes.

The topic, however, was more controversial among the interviewed practitioners (S2). Some wholeheartedly prescribed to the idea of encouraging external focus during the rehabilitation, while others highlighted the importance of developing internal focus to supervise the corrections in the performance-specific movements. Those who use an external focus of attention in their practice argued that the deterioration of the movements is partially due to an excessive internal focus, i.e., reinvestment; therefore, breaking the musician's superfluous focus on their affected body part would counteract the dystonic behaviour. The literature supports this notion on many different levels; apart from sports settings (Wulf, 2013), the benefits of employing an external focus of attention have been examined in music performance settings as well, and it has been concluded that it enhances technical precision and musical expression (Mornell & Wulf, 2019; Williams, 2019). Additionally to instructions to direct the attention externally, in some practices, musicians are distracted in various other ways to disrupt the constant supervision of their motor patterns, such as listening to music through headphones while playing, or engaging in an additional task (S2.2). However, being distracted might not be an ideal cognitive state for learning, as Wulf & McNevin (2003) demonstrated in their study, where they compared the performance of groups completing a balancing task under various conditions: their findings clearly show that being distracted by an external task did not produce the same benefits as the conscious external focus. It has to be noted, however, that the study, just as the bulk of the literature, used healthy participants; therefore, all conclusions drawn from it regarding MFD might not be fully translatable.

Other participants from S2 on the other hand, emphasised the importance of internal focus during rehabilitation from MFD. They argued that the use of external focus would lead to the execution of habitual movement patterns which are contaminated by the symptoms of MFD, and suggested that slow, controlled, and carefully supervised movements would allow the musician to correct the dysfunctional patterns (S2.2). Various interventions centred around slow practice seem to reinforce this notion (Sakai, 2006; Yoshie et al., 2015). This contradiction in the opinions might be solvable if the strictly binary view of the direction of attentional focus (internal versus external) is abandoned. As Allingham et al. (2021) argue, the simplicity of this understanding might not be appropriate to fully capture the complex procedure associated with playing an instrument: additional factors, such as the auditory feedback, musicality, emotions, and the resonations of the created sounds might complicate this equation. In Atkins's (2017) study, trained singers benefitted from internal focus, and the author concluded that the additional tactile sensations introduced by focusing on the sound production might have benefitted the participants. Following this idea, Allingham et al. (2021) introduced an additional focus condition into their study on violin bowing: a somatic focus, targeting the sensations resulting from the interaction with the instrument (i.e., resonance) within the body, and found that this condition was superior to both internal and external conditions in terms of movement effectiveness. Chopyk (2021) reinforces the benefits of a somatic focus; they achieved the best rehabilitation results by turning their attention towards the air resonating inside their wind instrument.

Extrapolating from this, it is possible that simply championing internal or external focus in MFD treatment is an overly simplified approach. Including the embodied experience of playing an instrument and considering the role of interoception would potentially lead to a more detailed understanding of the role of attentional focus in the treatment of the condition. Nonetheless, pronounced internal or external focus might be necessary at certain stages of the recovery or in various situations (practice versus performance).

9. 4. Biomechanics, self-efficacy, and practice strategies

The core of any given rehabilitation strategy is practising motor movements with the goal of reinstating the lost patterns. This remains true across all therapeutic modalities, even if the process of practice is not directly aided and is self-led, like in purely pharmaceutical approaches. Even when the musician is only supported by oral medication or is given a Botulinum Toxin injection, the potential alteration in the movement behaviour can only be originated from the movements performed repeated during instrumental practice (Byl, 2006;

Sanger & Merzenich, 2000). It is clear from the literature that the repetition of constructive somatic exercises can impact the neurological networks underpinning the affected movement by inducing adaptive neuroplasticity (Candia et al., 2003; Yoshie et al., 2015). However, there are additional factors which can influence the quality of the movement, such as the psychological state the person is in (Larsson et al., 1995; Laursen et al., 2002; van Loon et al., 2001), the cognitive patterns accompanying the practice (Lohse et al., 2010; Lohse et al., 2011; Wulf, 2013; Wulf & Lewthwaite, 2016; Zachry et al., 2005), and previous experiences with the activity (Fuchs, 2003; Jansen, 2012; Juhan, 2003). Moreover, some musicians might have had an inefficient playing technique (Chopyk, 2021; S1; S2.1; S2.2) and postures (Tubiana, 2003) leading up to the onset which means that instead of attempting to reconstruct the original movement patterns, introducing some adjustments also might be necessary. Extrapolating from this, the rehabilitation exercises need to be carefully constructed and tailored to the individual, with all these additional factors in mind.

For many musicians, approaching the instrument with the goal of playing might be anxiety-inducing in itself (S2.2). This is unsurprising given the repeated adverse experiences with their playing due to the symptoms, and the accompanying negative emotional and psychological states. Moreover, the uncertainty stemming from the lack of conscious control and the often fluctuating symptoms (i.e., the musician has no reliable way of telling how their affected body part is going to react to the stimuli of instrumental playing) is anxiety-provoking in itself (Grupe & Nitschke, 2013). As Bennett et al. (2016) noted about the “yips” and Lost Movement Syndrome (both variants of task-specific focal dystonia), athletes develop a strong fear of the affected movement, dreading the experience and the physical and psychological consequences of the movement breakdown. This can be understood as anticipatory anxiety which can lead to a heightened autonomic response, decreases blood flow to the prefrontal cortex (Simpson et al., 2001), and raises respiratory frequency

(Masaoka & Homma, 2001), especially in individuals with high trait anxiety. It seems obvious that these reactions can have an adverse effect on the learning process itself and point towards the importance of structuring the rehabilitation strategy to eliminate their negative impact.

The therapeutic responses to these issues varied among the participants of S2. Some suggested changing the habitual way of approaching the instrument, i.e., introducing a new routine when engaging with any playing-related behaviour. These included adjusting postural alignment, breathing exercises, or simply including distractions to change the attentional focus. Many musician-coaches stressed the importance of making each task simple, attainable, and moving forward incrementally to ensure that the musician gains trust in their ability to perform the exercise. Essentially, this approach points towards the development of self-efficacy in the musician, i.e., the "belief in one's ability to accomplish a specific task" (Hendricks, 2015, p. 32). Self-efficacy has been discussed by many researchers in the field of music education and performance (Hendricks, 2014; McCormick & McPherson, 2003; McPherson & McCormick, 2006) and the main findings show that the musician's level of self-efficacy is a better predictor of achievement that their actual skillset.

As first identified by Bandura (1977), the four main sources of self-efficacy are mastery experiences, vicarious experiences, physiological state, and verbal/social persuasion, and these pillars have been adopted for the development of self-efficacy in music performance as well (Hendricks, 2015; Zelenak, 2014). It seems that the practitioners in S2 – consciously or unconsciously - already utilised this model in their practices to various extent. To fully exploit the benefits of this model, however, the theory and practice of self-efficacy in music performance should be tailored for the specific situation of musicians experiencing MFD. Generating mastery experiences might be challenging when attending to musicians with the disorder; the experienced symptoms clearly undermine their sense of accomplishment. As Chopyk (2021) articulates: “the mind is in disbelief that even the most basic function can be accomplished. The player simply cannot imagine what it would be like to successfully play even the easiest things” (p.73).

Yet, the examples of practitioners from S2 show that setting obtainable goals, however simple these might be, can support the musician to increase their confidence through accomplishing successful trials and, at the same time, avoid anticipatory anxiety. For the majority of the musicians with MFD who experience task-specific symptoms (Hofmann et al., 2015) the body’s capability to move in a controlled way in the absence of the instrument can be exploited in creating the exercises. Examples of this (S2.2) might be simple breathing exercises while touching the mouthpiece of a wind instrument to one’s face without the attempt to make an embouchure or touching the piano keys with the back of the hand instead of the fingers. These accessible tasks might restore a sense of control and trust in one’s own body and its ability to move in the presence of the instrument without experiencing symptoms. However, the simplicity of these types of exercises might carry a potential adverse effect as well: one’s subjective perception of the achievement moderates the sense of self-efficacy (Bandura, 1997) and if the musician compares the completed task to their pre-onset ability, the evaluation will surely be negative. Therefore, an important part of the provided guidance is to communicate the exercise’s role and place in the long-term rehabilitation strategy and to help the musician to reappraise their performance.

Vicarious experiences, i.e., observing someone else successfully completing the task, can also support the re-education process. In a broader sense, this can be observing musicians who successfully improved their playing ability or recovered from the condition. In the cases where the therapist is a musician-coach who rehabilitated themselves (as seen in several examples in S2), this vicarious experience is naturally generated. As one participant noted (S2.2), the therapist’s personal history with the condition builds trust in the process. In a narrower sense, vicarious experiences can be generated on a micro-level, with the therapist demonstrating the task at hand. The last two sources of self-efficacy, positive verbal social persuasion (i.e., feedback or praise) and the desirable psychological and affective states were already discussed in detail in the previous sections titled “Mindset, identity, and psychological support” and “Constructing the environment” stating the importance of effort-based praise and the construction of a safe environment to contribute to a balanced psychological and emotional state; therefore, no further discussion will be offered here.

In summary, using attainable exercises, providing demonstrations, generating an accepting and welcoming atmosphere and challenging the musician’s inaccurate self-perceptions can be useful tools to enhance self-efficacy in the musicians (Hendricks, 2015) which might have further implications for their wellbeing, movement behaviours, and their development.

The other major finding of S1 was that musicians who were affected by MFD had ongoing issues with their instrumental technique, years, sometimes decades before the onset of the condition. Also, musician-practitioners in S2 frequently mentioned that their clients had additional technical or biomechanical shortcomings apart from the obvious MFD symptoms, such as postural problems or inefficient breathing strategies in wind players. While many researchers described and catalogued the most typical motor patterns experienced after the musician was affected by dystonia (Ackermann & Altenmüller, 2021; Frucht et al., 2001; Tubiana, 2003) the quality of the motor movement used before the onset received much less attention. It is clear from the literature that some preceding problems might be present, such as overuse (Altenmüller et al., 2014), corrective motor mechanisms to meet otherwise unattainable requirements (Sadnicka et al., 2018), repeated practice in a fatigued state (Grünewald, 2007), changing the instrument, or the technique used (Sadnicka et al., 2018), or age-related physical decline (Sadnicka et al., 2016). The biomechanical quality of the initially learned technique, however, remains under-researched.

There is a growing body of evidence for the relationship between musculoskeletal injuries and instrumental technique (Visentin & Shan, 2004; Waters, 2020a). An inefficiently automatised technique can lead to an acceptable, even outstanding, performance; however, it might overload selected joins and/or create excessive muscle tension leading to various performance-related problems (Chan & Ackermann, 2014). As Visentin & Shan (2004) articulated, it is important to “differentiate between physiologic tolerance (a time-based concept) and physiologic limits (momentary impact conditions)” (p. 90), i.e., the immediate success in performance does not indicate that it can be maintained in a similar manner without suffering some long-term adverse consequence. In terms of acquiring MFD, Sadnicka et al. (2016) theorised that some physical, performance-related risk factors (e.g., workload, practice hours) can accumulate over time and “only after a combination of ‘hits’ will dystonia start to develop” (p. 3.); a notion which could explain how participants in S1 maintained a high level of playing while struggling with certain aspects of their instrumental technique for many years before experiencing the symptoms.

The fact that a portion of musicians might have had inefficient playing technique prior to the onset has further implications for the rehabilitation: it requires a therapeutic response rooted in instrumental expertise because instead of aiming to restore the exact same way of playing as before the onset, certain modifications might be necessary to install a biomechanically correct technique. In the case when the treatment is led by a musician-coach, this expertise is already included in the approach, but in other therapist-led practices, the recruitment of a music teacher seems important (Van Vugt et al., 2014). As Tubiana (2003) writes, “the collaboration of instrumental teachers is also desirable and may be of great help” (p. 169).

Practitioners also highlighted the importance of attending to the biomechanics of the entire body when playing and stated that the problem is usually much more widespread, and not restricted to the body part where the symptoms are directly experienced. The role of general posture in music performance received increasing attention in the past decades (see Blanco-Piñeiro et al., 2017 for a comprehensive review). Maladaptive and inefficient postural playing habits have been linked not only to musculoskeletal injuries and overuse (Steinmetz et al., 2010; Visentin & Shan, 2004) but the impairment of the instrumental technique as well (Blanco-Piñeiro et al. 2015; Blanco-Piñeiro et al. 2017). More specifically, postural misalignment has been identified as a common feature of musicians with MFD by Tubiana & Chamagne (2000) and its correction as one of the core elements of rehabilitation. In fact, of their re-education program's (Chamagne, 2003; Tubiana, 2003; Tubiana & Chamagne, 2000) four main phases (restructuring the body image, independence of limb movement, re-teaching movement and posture, and return to the instrument) only the last one includes exercises on the instrument itself, the first three are designed primarily to enhance proprioception (i.e. the ability to detect the position of one's body in space), correct postural quality, and to develop muscular balance and strength in the affected areas. A similar anatomy-based program was developed recently by Ackermann & Altenmüller (2021) and body-oriented techniques were identified by Jabusch & Altenmüller (2006) as a significant element of MFD rehabilitation.

In summary, postural misalignment and inefficient postures both during performance and in general seem typical problems which need to be addressed alongside the more playing-specific exercises. Therapists who are physiotherapists or have a background in another body-oriented approach (e.g., Feldenkrais Method, Alexander Technique, Body Mapping) can employ their expertise when attending to musicians with MFD; in other practices led by music educators or other practitioners, collaboration with a somatic therapist might be necessary.

9. 5. Ethical considerations

Despite the efforts of neurologists, therapists, practitioners, and musicians, there is no reliable cure for MFD (Jabusch & Altenmüller, 2010). There are very promising treatment approaches and success stories, but when offering support and communicating the potential outcomes, caution is advised. Musicians who are affected by the disorder are highly vulnerable psychologically and should be treated with compassion but honesty at the same time. Communicating that there is no hope for recovery or stating that a particular strategy is reliable can be equally damaging.

The first can result in further deterioration in the mental health of the musician and rob them of any motivation to better their circumstances. Improvement in motor control is frequently observed (Altenmüller & Jabusch, 2010; Enke & Poskey, 2018; Tubiana, 2003) and many musicians stay in the profession. Moreover, after the initial shock of the onset, musicians with MFD improve their quality of life to the level that it becomes comparable to their healthy counterparts (Lee et al., 2015) which clearly points towards the possibility of managing the condition and its implications on mental health and self-perception. Therefore, it is important to clearly communicate the potential outcomes in order to allow the musician to formulate an informed decision about their approach (Enke & Poskey, 2018).

Stating that a specific approach “cures” the disorder is highly unethical. Unfortunately, this “guru-ism” is rampant in the community with individuals propagating one approach over the other, sometimes based on personal experiences or convictions, other times for financial gains. Online support groups, such as the Musicians with Focal Dystonia group on Facebook are stages of frequent aggressive outbursts, shameless advertising of specific methods, and the humiliation and belittling of fellow musicians with the disorder. Most advertised methods are unifactorial, hold a simplified view of the disorder, and are rarely transparent. Some videos and texts use medical vocabulary incorrectly and explain neurological concepts to their patients without the appropriate knowledge. Examples include books like *The focal dystonia cure* by Ruth Chiles (2022) which promises complete recovery by primarily using a set of meditation exercises, or practitioners who are convinced that the symptoms are purely an emotional problem (Fabra, n.d).

The methods described in these spaces might provide relief for some of the affected population; the issue lies with the musicians who do not experience any improvement after following through with a time-consuming program meticulously. As one participant in S2.2 articulated, the responsibility is often placed on the musician at the conclusion of such a failed therapy which might deepen their psychological distress. Furthermore, some approaches might do more harm than benefit, introducing additional compensatory movements to the affected body part. In addition to the questionable outcome of these approaches, they place a substantial financial burden on the musicians who, due to their inability to fulfil their roles as performers, might already have financial difficulties. Some practitioners refuse to work with the musician unless they commit to the therapy for a prolonged time, while others are charging unacceptably high hourly rates.

In summary, the key to treating musicians with the disorder ethically is transparency and honesty, and the acknowledgement that there is a large variability in the severity and presentation of the disordered patterns in addition to the individual differences in previous experiences, including traumatisation, personality traits, and circumstances. It is possibly safe to say that the best way to support musicians with the disorder is to develop a “portfolio treatment strategy” tailored to the individual’s needs after careful exploration, and involving multiple professionals with different expertise in neurology, somatic approaches, psychoanalysis, and instrumental education.

Chapter 10. Implications for prevention

This chapter corresponds with the third identified goal of the research (Chapter 1., Section 1.1.), namely, the new model's implications for preventative strategies. First, the cultural, traditional, and institutional environment is discussed to situate the subsequently presented recommendations in a broader context. Then, based on the overall findings, suggestions are made to music educators in five subsections, which are introduced in the following order: 1. Learning environment, social connections, and enjoyment, 2. Feedback, success criteria, and perfectionism, 3. Autonomy, competence, expectations, and self-efficacy, 4. Attentional focus, and 5. Health awareness, biomechanics, and instrumental technique.

Up until recently, MFD, alongside other task-specific and non-task-specific variants of dystonia, was considered an exclusively neurological disorder (Marsden, 1976; Munts & Koehler, 2010); a model which did not offer possible avenues for prevention since the suggested contributing factors, such as the genetic makeup, are not pliable. However, the past decades' research opened this narrow perspective and moved towards a more holistic view of the condition, identifying new possible contributing factors, such as personality traits, maladaptive cognitive strategies, and practice behaviours (Altenmüller et al., 2014; Enders et al, 2011; Jabusch & Altenmüller, 2004, Jabusch & Altenmüller, 2009; Sadnicka et al., 2018). Additionally, the three studies presented in this dissertation (S1; S2; S3) contextualised the disorder and provided further hypotheses regarding the role of the social environment and the received music education, and concluded that there is a relationship between how the affected skill was learned and performed and the onset of MFD. Since many of these variables - especially the pedagogical approach and tools used in music education - are manipulable, it is possible to formulate recommendations for the development of preventative strategies. Given that MFD is notoriously difficult to treat, and the success rates of the currently available treatment approaches are low (Enke & Poskey, 2018; Jabusch & Altenmüller, 2006), prevention should be a high priority.

Prevention needs to start at the very first lesson and continue throughout all the stages of becoming a professional musician (Altenmüller, 2021). This long journey encompasses various developmental levels; however, they are all characterised by the traditional, individual teaching model, and similar teaching strategies. Therefore, for the most part, the recommendations are made in a general manner, only differentiating between different settings (e.g., general music education, studio settings, conservatoires, and higher education) where there are meaningful differences, and the suggestions are made for a specific environment.

Before the elements of a possible preventative strategy will be discussed, it is important to understand how the traditional teaching approaches and educational environments evolved in the field of music education and how these models and pedagogies are maintained (Duffy, 2013; Ford, 2010) despite the growing evidence that they do not always serve the best interest of the individual musician (Carey et al., 2006; Jørgensen, 2000; Patston, 2014; Rostwall & West, 2003). These practices are preserved, even protected on both an institutional level (Duffy, 2013) and within the individual relationships between a music teacher and student (Presland, 2005; Rostwall & West, 2003) due to the habitual continuation of the traditions and the belief that this educational strategy is optimal for meeting the high expectations of the music industry and audiences.

The current traditions of educating professional musicians in specialised institutions go back to the 1800s when the first colleges and conservatoires opened in Europe (Ford, 2010). This type of education is characterised by intensive bursts of individual tuition (typically in weekly frequency) with the primary focus on the development of technical, instrument-specific skills (Duffy, 2013; Williams, 2019). The demand for the complexity and flawlessness of these skills has been gradually increasing, starting in the early romantic period with the appearance of the new stereotyped “virtuoso musician” (Levin, 2010): outstanding musicians like Paganini and Liszt pushed the boundaries of technical skills and set a new standard to music performance (Palmer, 1998). It is interesting to note that the first written records of MFD coincide with this period, signalling a relationship between the demands placed on the musicians and the development of the disorder (Altenmüller, 2006; Altenmüller, & Jabusch, 2009).

Starting from this era, the accomplishments of these virtuosos prompted the next generation of musicians to achieve similar feats, and this process has only accelerated with the advancement of music production and recording which resulted in the growing availability of recorded music (Chanan, 1995). Together with the expanding need for virtuosity and the development of recordings, music-making, and the required skillset shifted from a more flexible and creative practice filled with improvisation to playing notated music in a precise and much more prescribed manner (Shane, 2013). In response to the growing demand for virtuosity and more and more complex accomplishments, music performance and its education had to become increasingly specialised due to the required time commitment for practice and develop strategies to produce highly skilled individuals who are able to fulfil the task. The right candidates were selected based on a strict audition process, and the starting age for professional education was pushed back: in some counties, conservatoire programs begin at the age of 11 or younger (Delfrati, 2021; Pásztor, 2021), but more importantly, the process placed the focus of attention progressively on the technical skills and accumulating large amounts of practice because it seemed to be the best response to the demands.

This idea of “quantity equals quality” has long been a fundamental concept in motor learning (Guadagnoli & Lee, 2004): the positive correlation between practice time and attained skill has been shown repeatedly and so reliably that the principle is sometimes considered a law (Newell & Rosenbloom, 1981). In music, this view was furthered by Ericson et al.’s work (1993) which argued against a long-held notion of hereditary and inborn talent and replaced it with the theory of deliberate practice (Ericsson, 2002). Inarguably, deliberate practice is the cornerstone of expert performance, but it might provide a somewhat limited and oversimplified view of how motor skills are developed. As Lehmann (1997) observed, from a music educational perspective, the role of supervision and the cultivation of self-regulatory practices are highly important factors, lacking from the original model. Moreover, other pieces of contextual information, such as the cognition, motivation, psychological states, and emotion of the individual, and the social and cultural context in which the learning is taking place cannot be neglected (Wulf and Lewthwaite, 2016).

Wulf and Lewthwaite (2016) argue that the models based on exclusively the amount and patterns of practice lead to an incomplete understating of movement acquisition and state that “it has become clear that the view of humans as processors of neutral information does not capture the breadth or variety of influences on motor behaviour” (p. 1384). They proposed the OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning) model, which expands on previous models by including social, motivational, and attentional factors, providing a broader and more holistic understanding of human motor behaviour. The additional domains of this more holistic view of motor acquisition align with the newly identified contributing factors to MFD (S1; S2; S3), potentially signalling that the narrow and inadequate understanding of motor learning and its impact on music education generates an environment which might precipitate the onset of MFD in certain individuals. This connection also indicates that there is a broader problem with the traditional system of music education practices since it operates on the premises of outdated models of motor learning. Thus, the current approaches might be less than optimal for every musician but for those who are genetically or otherwise predisposed, can lead to grievous consequences. However, it also implies that there is a great potential in integrating the recently emerged information about motor learning into music education and using it for developing preventative strategies for MFD and more broadly, to enhance the educational experience and its outcome for music students.

Outstanding music educators and researchers already recognised the need for rethinking and reforming the traditional educational strategies by recognising their shortcomings and using the information to develop more student-centred guidelines. Research has been conducted to explore various settings from studio classes (Patston & Waters, 2015) to conservatoire cultures (Perkins, 2013), in different age groups from young learners to students in higher education, and on numerous topics, such as motivation (Cogdill, 2015; Woody, 2021), self-efficacy (McCormick& McPherson, 2003; McPherson & McCormick, 2006), student-teacher relationships (Gaunt, 2011; Presland, 2005; Rostvall & West, 2003), performance-related health (Détári & Nilssen, 2022; Matei & Ginsborg, 2022; Salonen, 2018), learning cultures (Perkins, 2013), and many more. This literature will also be fully utilised and exploited in this chapter, and links will be established to various movement acquisition theories to directly target the educational factors which possibly contribute to the onset of MFD.

In summary, the three main sources informing the recommendations are 1. the potentially dangerous shortcomings of the current music education system that are highlighted by the findings of the three studies presented in this thesis, 2. novel and ground-breaking approaches to motor learning informed by the latest experimental and observational findings of neuroscience, psychology, and sports psychology and 3. the aforementioned music educational approaches which already established valuable concepts directly on the field of music education. These three pillars will be used to theorise an approach which is better suited to develop, support, and sustain healthy movement behaviour in musicians, by capturing various, previously neglected aspects of motor learning, and as a result, potentially provide protection from MFD for the next generation of professional musicians. Whenever possible, practical advice will be provided for music educators to implement in their teaching practises.

10. 1. Learning environment, social connections, and enjoyment

The first and possibly most fundamental principle of prevention is that instrumental learning must take place in a positive, accepting, and safe environment. As the findings of the dissertation show, many musicians with MFD reported that they studied in a negative emotional climate and were subjected to emotional, in some cases, sexual abuse (S1; S2.1; S3). This lack of psychological safety propagated various issues and had a significantly negative impact on not only the musicians' psychological states but possibly also on their learning process and motor behaviour. Sometimes, these degrading and humiliating forms of teaching stemmed from the conviction that it will motivate the students, i.e., they will adhere to the given instructions to avoid further punishment (S1; S2.1). Unfortunately, this culture of abuse is frequent in many competitive artistic and sports training practices and recent research is in the process of revealing its destructive and damaging nature, both on a psychological and a somatic level (Lakes, 2005; Stirling et al., 2020).

Therefore, in order to enhance the well-being, learning experience, and psychological and physical health of music students, the role of the constructed environment needs to be taken seriously. Some researchers even claim that the context in which the learning takes place is a better predictor of the outcome than the content (Gruhn, 2004; Lakes, 2005).

Learning and teaching are social acts (Gruhn, 2004) and the presented material cannot be divorced from the way it is communicated: the way a task is introduced, and the provided feedback can have a significant impact on the learners' motivation (Dweck & Masters, 2012; O'Neill, 2011), self-efficacy (Patston & Waters, 2015), and motor behaviour (Wulf, 2013; Wulf & Lewthwaite, 2016). This effect can be also analysed and understood from a neuroscientific viewpoint: neuroplasticity (the process through which the brain created and reinforces connections between neurons) is driven by the interplay between the stimuli arriving from the environment and the individual's characteristics. If the action meets with positive external reinforcement, it will enhance plastic adaptations (Altenmüller & McPherson, 2007), it is more likely to be repeated and as a result, stored in long-term memory (Gruhn, 2004). As Gruhn (2004) puts it "only emotionally reinforced meaningful information provides a chance for sustained learning".

The relationship between the students' musical development and the atmosphere and emotional climate in the lessons has also been pointed out by Gembris & Davidson (2002) when they noted that "children who develop outstanding instrumental achievements tend to have learned in a positive emotional atmosphere that was enjoyable and free of anxiety" (p. 23). Personal contact with the tutor is especially important for young learners who do not differentiate between the teacher's perceived personality and their behaviour towards them, and the quality of the imparted information (Davidson et al., 1995/1996). In other words, the emotional states accompanying the learning and the characteristics of the experience can substantially influence the process of learning.

One of the most important attributes of a positive learning environment is safety. The state of psychological safety is when the individual does not fear emotional or psychological repercussions following their actions and feels comfortable with taking interpersonal risks and exercising agency (Edmondson & Lei, 2014; Wanless, 2016). It has first been studied in the field of business (Edmondson, 1999; Edmondson & Lei, 2014) but more recently, it has been explored in relation to developmental psychology and learning (Holley & Steiner, 2005; Wanless, 2016), where it has been linked to learning, engaging with new experiences, making choices, setting and accomplishing goals, and self-regulation (Merritt et al., 2012; Wanless, 2016), and in general, was identified as a fundamental facilitator of personal development. So far, there are no studies exploring the concept in music educational settings; therefore, the following recommendations are based on conclusions drawn from classroom education.

Wanless (2016) suggests considering psychological safety as the result of both individual and environmental (contextual) characteristics. In other words, psychological safety appears at the intersection of the person's individual needs and the attributes of the environment in which the interaction takes place; in both variables, there are substantial variations. The personal side of this equation is the less pliable; the best practice here is to increase sensitivity and empathy to be more aware of the individual's specific needs (Seligson & MacPhee, 2004). For educators, it is important to acknowledge that apart from innate personality traits, the student's perceptions of the levels of psychological safety and perceived risks in a situation are also affected by previous experiences. These can include experiences from early developmental stages, for example, a history of insecure attachment in childhood can lead to heightened sensitivity to potential rejection and lower levels of psychological safety (Fang et al., 2014; Wanless, 2016). This stresses the point that creating psychological safety must be tailored to the individual.

The other variable is much more manipulable: there are several easily utilizable tools which can create a "safe space" for the students in an educational environment (Holley & Steiner, 2005). One of the most important cornerstones of creating a psychologically safe environment for the individual is an emphatic personal relationship with the tutor in a warm, non-judgmental, and welcoming atmosphere (Latting, 1990; Wanless, 2016). This allows the student to develop trust in their teacher, discuss potentially uncomfortable topics, open up about their issues, try out new things, and challenge themselves without the fear of being ridiculed. Holley & Steiner (2005) approached the topic from the students' perspective and identified the most important characteristics of an instructor who is able to create a psychologically safe space for them to learn: the unbiased and non-judgmental attitude of the teacher, clearly articulated expectations and "ground rules", and a respectful, encouraging, supportive, and friendly demeanour. Students in this study also valued a teacher who is "comfortable with conflict, raising controversial ideas" (p. 56). This points towards another important characteristic of a psychologically safe environment, namely, that psychological safety does not equal stress-free or unchallenging. In fact, feeling psychologically safe is the variable which enables students to face challenges and difficulties in order to grow. In a classroom environment, these difficulties can include voicing unpopular or controversial views in order to receive new perspectives on a topic, facing one's biases, and examining their values, beliefs, and behaviours with a critical eye (Holley & Steiner, 2005). While the setup and context are different in one-on-one instrumental teaching, it is possible to pinpoint elements that might be equally challenging for an instrumental student and requires adequate levels of psychological safety in order to face them. Disagreeing with the teacher on certain aspects of the performance or the repertoire choice or reporting physical discomfort could be examples of such difficulties.

It is also important to understand what constitutes an unsafe environment and which elements can aggravate the feelings of vulnerability to avoid creating such situations. According to Nembhard & Edmondson (2006), there are certain factors which can decrease psychological safety, such as unclear instructions, tasks with strong identity-related elements, and a more pronounced hierarchy. In music education, there is an unfortunate capacity for all these characteristics. Music teachers often use metaphors to communicate content which can be interpreted in many ways (Détári & Nilssen, 2022) and being a musician is often an important source of identity, especially in higher education (Kemp, 1993; Sanders, 1998). Moreover, both in music schools and in higher education, teaching often follows a master-apprentice model (Duffy, 2013; Haddon, 2009; Hyry-Beihammner, 2010) which implies an asymmetrical power structure.

The findings of Rostvall & West (2003) show how these unfavourable characteristics can deter students from learning: when observing 11 beginner-level instrumental lessons, they noted the teachers' tendency to abuse their power by ridiculing the students' verbal initiatives and leading the session in a teacher-centred and authoritative way. In higher education, Gaunt (2011) observes that this power dynamic has a direct impact on the social dimensions of the student-teacher relationship, which can prevent the student to articulate their difficulties. Students in Holley & Steiner's (2005) study felt that this type of chastising, critical, and rude attitude led to a psychologically unsafe environment. They also highlighted their psychological discomfort when tutored by opinionated and judgmental teachers who taught in an authoritative and didactic manner. In summary, it seems clear that controlling, demeaning, and belittling verbal behaviour undermines the student's basic needs for psychological safety. Optimal motor learning can only take place when the fundamental psychological needs are met, or at least, not directly threatened (Wulf & Lewthwaite, 2016). The psychological need for safety is one of these fundamental needs, and teachers must understand their role in creating such an environment to enable learning.

10. 2. Feedback, success criteria, and perfectionism

The safety of the learning environment is also cultivated by the communication between the student and the teacher. The findings presented in this dissertation paint a rather negative picture of this aspect of the teacher-student relationship, characterised by harsh criticism and unattainable demands placed on the musicians who later were affected by MFD (S1; S2.1; S3). The criterion for success was no less than "perfection" and if not achieved, the students' talent and identity as musicians were questioned (S1). The psychological consequences (decreased psychological safety) of this type of communication were already detailed in the previous section, but it has further implications for motor learning as well.

It has been shown in a series of studies that positive feedback enhances the motor learning process and has a direct impact on motor behaviour (Avila et al., 2012; Badami et al., 2011; Chiviacowsky et al., 2012; Palmer et al., 2016; Wulf & Lewthwaite, 2016). The results from these studies have shown that positive social-comparative feedback (i.e., the praise has a comparative element to peers highlighting the individual's superiority) and positive normative feedback (i.e., feedback which does not mirror the actual quality of the performance but overemphasises the accomplishment of the individual) improves self-efficacy (Avila et al., 2012; Lewthwaite & Wulf, 2012) and leads to superior motor learning and performance in terms of automaticity and efficiency (Wulf & Lewthwaite, 2016).

Naturally, this does not imply that the ideal learning environment is characterised by constant positive feedback without constructive criticism. Correcting mistakes and making suggestions for further improvement remain a key element of music education (McPherson et al., 2022); in fact, instrumental teachers give disproportionately more negative feedback than classroom teachers (Duke & Henninger, 1998). However, the delivery and tone of such criticisms make a huge difference in how the feedback is received and implemented. There are several suggestions in the music education literature on how to use feedback to enhance motivation and further learning and promote both wellbeing and progress in the taught skill simultaneously.

Bartholomew (1993) stressed the importance of encouraging students by drawing attention to the positive aspects of their performance before discussing possible avenues for improvement. They contended that generic praise (e.g., "well done") might not accomplish the goal of motivating the student; more specific feedback, directly connecting to the performance and highlighting the strengths and the elements or actions contributing to it can make the feedback more relatable. A recent novel approach (McPherson et al., 2022) presents a detailed framework for providing feedback with three different levels: feedback (reflecting on previous performance and identifying areas for further improvement), feed-up (comparing the learner's present performance to a desired future state), and feed-forward (focusing on the developmental trajectory of the student). Using feedback from these three levels proportionally can help the student to see the process of developing their skill by examining it reflectively and setting short and long-term goals. Moreover, McPherson et al. (2022) also differentiate between task-level, process level, and self-regulation feedback; among these, task-level feedback (correcting mistakes) is the most common in music education (McPherson et al., 2022), yet it might not be the most effective. Both process-level and self-regulatory feedback encourage the student to learn strategies to monitor and correct themselves and has further benefits in terms of individual practice.

Another comprehensive model is the Positive Instruction in Music Studios (PIMS) model (Patston & Waters, 2015) which is a framework based on Positive Education (PP) (Seligman et al., 2009), and more broadly on the concept of positive psychology (Seligman & Csíkszentmihályi, 2000). The four basic pillars of this approach are positive priming, strength spotting, positive pause, and process praise (Patston & Waters, 2015). Positive priming is a structural element: starting the lesson with a material the student enjoys to prompt feelings of competence. While this opposes the traditional framework of an instrumental lesson (starting with a warm-up, followed by technical exercises, and finally performing concert pieces), Patston & Waters (2015) argue that "this process will engage the student's mental, musical, and technical focus more rapidly than a demonstration of scales" (p. 5). Strength spotting and positive pause are concepts which allow the teacher to highlight the students' personal strengths and positive qualities, and to take time to emphasise elements which were executed well. As already discussed, this positive prompting has a significant impact on motor behaviour (Avila et al., 2012; Badami et al., 2011) and fosters feelings of competence. The last element in this model is process praise, a concept which originates from Dweck's work (Dweck, 2007; Dweck & Masters, 2012) on the relationship between mindset and learning. The essence of this idea is that commenting on the progress rather than the skill strengthens the self-belief in the ability to grow, maintains intrinsic motivation, and enhances self-efficacy.

Another important factor which might influence the quality of the feedback is the set task criteria, i.e., what is perceived as a successful attempt by the tutor. The tutor's perspective on this and the feedback they give will inevitably shape the students' ideas of success and failure. As Patston (2014) points out, "for many teachers, striving for achievement can often result in striving for perfection" (p. 91), which can have a detrimental effect on music learners. If the parameters of a successful performance only allow for the "perfect" execution of the musical piece, they will remain unattainable for the learner and can lead to negative consequences both on the level of psychological wellbeing (O'Connor & O'Connor, 2003) and movement execution (Chiviacowsky et al., 2012; van Loon et al., 2001). This socially prescribed perfectionism was frequently reported as part of the dystonic musicians' educational experience (S1; S2.2; S3) and self-oriented perfectionism is one of the most discussed psychological traits in relation to musicians with MFD in the literature (Enders et al., 2011; Jabusch et al., 2004).

As Chiviacowsky et al. (2012) observed, the individual's understanding of the acceptable margin of error can directly impact motor performance: in their experiment, participant groups were given different parameters of what constitutes a "good" performance.

The group which was given the smaller margin of error performed the task with less accuracy and showed lower levels of self-efficacy compared to the group which was given less strict success criteria and the control group. The authors hypothesised that by receiving a more stringent task requirement, the learners were deprived “of the opportunity of experiencing competence through good performance” (Chiviacowsky et al., 2012, p. 1).

This underlines the importance of the social component in the development of perfectionism (Hewitt & Flett, 1991; O’Connor & O’Connor, 2003), especially the role of authoritative figures: it seems that parents (Domocus & Damian, 2018; Frost et al., 1991), coaches (Dunn et al., 2006; Madigan, 2019), and teachers (Patston, 2014; Patston & Osborne, 2016; Stoeber & Eismann, 2007) have a significant role in the development of perfectionism. However, this influence can also be directed towards actively dismantling self-oriented perfectionism and perfectionist concerns (Domocus & Damian, 2018). According to Patston (2014), the vernacular used in lessons can be a useful tool to avoid encouraging perfectionist tendencies in young musicians and Domocus & Damian (2018) observe that the teacher’s support and creating social connectedness can serve as protective factors against maladaptive perfectionism.

The idea of social connectedness connects back to the already discussed teacher-student relationships and the idea of consciously constructed environments. In Blackwell’s (2022) case study of a successful violin studio practice, the notion of a welcoming atmosphere, quality feedback, and reduced perfectionism is interconnected: the interviewed students described a nurturing learning environment characterised by non-accusatory and non-judgemental feedback, and attainable expectations. In short, cultivating an environment where mistakes are not considered as deviations from the standard but as information to signpost areas for further improvement contributes to psychological safety and development, and disables perfectionist tendencies.

10. 3. Autonomy, competence, and self-efficacy

One of the frequently found characteristics of the music education received by those who were later affected by MFD was the authoritative teaching style, and as a result, the lack of autonomy (S1; S2; S3). The premise of this teaching approach is that tutor is the bearer of objective, indisputable knowledge which they communicate via statements and closed questions, and the student's task is to incorporate the information into their playing. The master-apprentice teaching model, which is still prevalent in higher music education (Haddon, 2009; Jørgensen, 2000) provides an "ideal" framework for this approach, and according to many practising teachers, it serves as a guarantee for high artistic standards (Duffy, 2013) because its personal nature (Hyry-Beihammner, 2010). This idea is in direct confrontation not only with the most recent guidelines for music education practices (Carey et al., 2017; Duke, 2012; Jørgensen, 2000; McPhail, 2013; McPherson & Hattie, 2022) but also with findings in the field of sports psychology (Katz & Westera, 2019; Wulf et al., 2014, Wulf & Lewthwaite, 2016).

Being able to exercise control over one's situation and actions is not only a deep-seated psychological need but also a "biological necessity" (Wulf & Lewthwaite, 2016, p. 1392): Leotti et al. (2010) found profound evidence that the need to control one's behaviour or manipulate the environment is fundamentally a survival instinct. Thus, being denied agency can result in various negative psychological outcomes: the perceived loss of control can result in impaired emotion regulation, fear responses, learned helplessness, and heightened levels of stress (Leotti et al., 2010). On the other hand, when the individual is granted autonomy, it is associated with increased self-efficacy (i.e., the conviction that they are able to complete the task at hand) and subsequently, competence (Wulf & Lewthwaite, 2016).

In order to inform recommendations for preventative strategies, the notion of autonomy and agency in music education will be explored in relation to two main subject areas: motor learning and education. These two areas approach the matter from slightly different angles, the first focusing more on the accuracy, effectiveness, and efficiency of the motor output, and the latter on the psychological benefits of fostering autonomy, but they have a common denominator: the goal of cultivating superior learning. For a well-founded preventative strategy, it is important to exploit both of these areas and incorporate their elements into music education given that the context and the task characteristics (i.e., instrumental learning is a unique blend of cognitive and motor learning) require support from both perspectives.

The role of autonomy in motor learning and performance is a relatively new area of research with interesting results. The positive and substantial effect of the learners' autonomy on motor output has been shown by a series of studies on various motor tasks (Hartman, 2007; Katz & Westera, 2019; Sanli et al., 2013; Wulf et al., 2014; Wulf & Toole, 1999). When learners are given a choice about the practice conditions when learning a new motor skill, it enhances and accelerates the learning process (Sanli et al., 2013). In these experimental studies, participants could exercise agency on various aspects of the learning process, such as deciding on practice amount, order of the tasks, using supporting devices, or the timing and manner of the feedback (Wulf & Lewthwaite, 2016). During the experiments, researchers compared self-directed and yoked conditions (i.e., when the dimensions of the task were prescribed to the participants) and found superior learning processes under the self-directed conditions in various movement tasks, such as balancing tasks (Hartman, 2007) and exercises on a ski simulator (Wulf & Toole, 1999). Surprisingly, even if the learner is given control over a minor and insignificant detail of the process, it still enhances efficiency: Wulf et al.

(2014) found that participants performed better in a throwing task when they could select the colour of the ball they used.

Educational literature also endorses the cultivation of autonomy in classrooms, and it is understood as the cornerstone of constructivist educational approaches (Pelech, 2010). Constructivism, opposing objectivism, creates and accumulates knowledge in active collaboration between the tutor and the learner, and allows the student to be an active participant in their learning rather than a passive recipient (Shively, 2015). The approach is highly promoted by various researchers because it stimulates competence, self-efficacy, motivation (Alt, 2015), and as a result, student satisfaction with the process (Fosnot 2005; Shively, 2015; Webster, 2011). Researchers in the field of music education also recognised the need to foster autonomy and independence in the students (Burwell, 2017; Carey et al., 2017; Duke, 2012) by using constructivist principles (Shively, 2015). These ideals can support the student's self-led individual practice which contributes to the performance outcome, perhaps more substantially than the time spent on the lesson (Jørgensen, 2000).

In addition to how the material is practised, the student's autonomy can also inform the individual playing style and decision-making in artistic and technical matters. These initiatives are often suppressed by teachers (Jørgensen, 2000; Rostwall & West, 2003) for various reasons. Classical music, by nature, relies heavily on the correct interpretation of the written score and many aspects of the performance are prescribed to the player. These restrictions, alongside the growing demand for precision and flawless performances, create the illusion that the musician has little room for independent artistic choices. Moreover, the "pressure to conform" which is "inherent in the musical and cultural society" (Jørgensen, 2000, p. 70) creates further boundaries to develop individual musical values, expression, and approaches; contradictorily, these are the values which are most celebrated in the greatest performers, rather than the perfect repetition of the notated music. Therefore, finding one's own voice, choosing one's repertoire, and actively participating in the choices regarding various aspects of the performance are important in order to achieve better artistic outcomes and also lead to more enjoyment and engagement (Carey et al., 2017).

There are several ways to support autonomy in instrumental learners. One of the most important factors is the communication which takes place in the lessons: autonomy-supporting language (i.e., giving space to the student to make their own choices) instead of instructive and controlling language can encourage the student to embrace and exercise their role as an active participant in their own learning process (Wulf & Lewthwaite, 2016). To achieve this type of communication, the frequent use of open questions (often referred to as Socratic questions) is suggested in the literature (Paul & Elder, 2007). These open questions can help students to reach conclusions on their own (Duke, 2012), instead of being the passive receivers of a seemingly objective piece of knowledge. However, incorporating open questioning into a teaching practice, regardless of the level of the learner, can be challenging. The two main obstacles are the teachers' habitual teaching style which is often based on their own education and favours interrogative and closed questions (Burwell, 2017; Duke, 2012; Visentin et al., 2008), and secondly, the students' responsiveness. The ability and willingness to answer open questions and exercise agency within one's own education is a skill which needs to be cultivated (Burwell, 2017); students who have been educated in a hierarchical master-apprentice model are not necessarily well prepared to engage in such conversations. Given the obvious advantages of a more constructivist and student-centred approach, these challenges need to be understood and met in teaching practices. In higher education, other tools have also been tested with the goal of identifying possible avenues to enhance the students' autonomy. Carey et al. (2017) investigated the use of reflective journals as a pathway to autonomous learning and concluded that the practice enhanced the "development of student autonomy; a sense of shared responsibility and collaboration; and increased clarity and confidence in the direction of their learning" (p. 99).

Despite the obvious benefits, many tutors might have difficulty embracing these autonomy-enhancing practices. Few teachers have been educated based on such principles and teachers have the tendency to model the education they received (Visentin et al., 2008) due to the lack of training in educational psychology and music education specifically (Haddon, 2009). Also, the expectations and traditions of conservatoires and other performance courses in higher education might be potential barriers; as Shively (2015) explains, these institutions are likely to "have more traditional expectations as to what constitutes music education" (p. 130). Therefore, guidelines and principles which foster autonomy and individuality need to be clearly expressed on an institutional level, and student independence needs to be supported by appropriate educational policies (Duffy, 2013). One great practical example of this is the recently implemented curriculum reform in the Royal Conservatoire of Scotland in the United Kingdom (Duffy, 2013), which transformed the educational setting to provide more autonomy for its students and "produce thinking artists, able to deal with artistic and intellectual challenges" (p. 173). One of the main principles underlying these educational reforms is the notion of enabling "students to take responsibility for managing and evaluating their own learning" (p. 175).

In summary, the importance of providing and fostering autonomy has been highlighted both in the fields of sports psychology and music education. The ability to make choices about one's learning material, individual expression, and the movements involved in the performance can support the learners' bodily movements as well as their psychological state.

10. 4. Attentional focus

Cognition and the direction of attentional focus seem to play a part in developing MFD: musicians who are affected by the condition often used excessive internal focus to supervise their motor movements when practising and performing (S1), in other words, reinvestment is often observed (Altenmüller et al., 2014). In the participants of S1, this strategy partially seemed to stem from perfectionist tendencies and anxiety, as they were trying to avoid making mistakes, but in many cases, it was also actively taught to them to achieve flawless performance. Based on these findings and the rich literature on attentional focus and cognitions accompanying performance, the section is going to discuss the pedagogical implications in the light of three assumptions: 1. the direction of attentional focus can modify the motor output and as a result, performance quality, 2. anxiety and perfectionism steer the attention towards reinvestment and unnecessary supervision of the movements, 3. the direction of the attentional focus used during practice and performance can be influenced by pedagogical strategies.

The role of attentional focus in movement acquisition and performance is thoroughly researched in sports psychology (for a comprehensive review, see Wulf, 2013). Repeated experiments in various circumstances and tasks provided robust evidence of the superiority of external focus of attention (the attention is directed to the goal or aim of the intended movement) over internal focus of attention (the attention is directed within the body, especially the body part performing the movement) (Masters, 2012; McNevin et al., 2003; Wulf, 2013). Following this initiative, the phenomenon was examined in instrumental learning as well (Duke et al., 2011; Mornell & Wulf, 2019; Williams, 2019) and it was concluded that the external focus of attention enhances not only the execution of the necessary movements but also musical expressivity.

When it comes to the early stages of learning, however, the evidence supporting the benefits of external focus has been inconclusive. Stambaugh (2017; 2019) compared internal and external focus of attention conditions in novice wind and brass students and found no conclusive evidence that external focus of attention enhances pitch accuracy or the evenness of sound. In these studies, however, participants were instructed to focus on their fingers under the internal focus condition which might not be appropriate in wind players as the sound production largely happens in the embouchure. Nevertheless, the study raises the question of whether an internal focus of attention would be beneficial before at least the basics of the skillset are automatised. It is possible that due to other factors influencing the early stages of motor learning, there is no straightforward answer: the age of the learner and their metacognitive abilities (Masters et al., 2013), moreover, the individual's motor ability (Maxwell et al., 2017) can influence the learning process. Younger children naturally employ a more external attentional focus while modelling and copying others' movements (Masters et al., 2013); this way of explicit learning lacks metacognition, i.e., conscious planning. On the other hand, young learners can be instructed to turn their focus towards their bodily movements, and in those who have more aptitude for the task, this seems to enhance their learning progress (Maxwell et al., 2017).

Viewing attentional focus as a binary concept (internal vs external) can also be a boundary to deriving conclusions and developing pedagogical strategies to support instrumental learners. Attentional focus can also be directed inwardly without being preoccupied with performance-related fine motor movements. In fact, many somatic strategies, such as Alexander Technique, Feldenkrais Method, and Body Mapping invite the individual to pay attention to their various body parts as they are engaging with different tasks and develop efficient movement habits by improving conscious embodied awareness; these somatic methods are frequently used with musicians to enhance performance, and physical and mental well-being (Paparo, 2022; Salonen, 2018; Valentine et al., 2022). Therefore, the difference between different types of body-oriented foci needs to be articulated and separated in the vernacular and research: embodiment (increased interoception) is associated with mindfulness (Khoury et al., 2017) and positive changes to affective states (Weineck et al., 2020) while internal focus or reinvestment (placing the attention directly on the body part which is performing the movement, e.g., the fingers or the embouchure) can lead to increased tension and less efficient movement behaviour (Lohse et al., 2012; Marchant, 2011; Masters et al., 1993; Wulf, 2013). Additionally, focusing on the contact points and interactions with the instrument can be beneficial in terms of performance: the tactile sensations and resonance resulting from this type of focus of attention can lead to even more efficient movements than an exclusive external focus of attention (Allingham et al., 2021).

The literature presented thus far explored the impact of various attentional foci in experimental settings where participants were instructed to direct their attention internally or externally. In real-life settings, however, the individual's attention is influenced by various internal and external factors, such as personality traits, psychological states, conscious or unconscious cognitive strategies, and situational stimuli. Sport psychology research also examined the topic of internal focus in anxiety-provoking situations, such as competitions, and concluded that under pressure, certain individuals tend to supervise their movements during the execution of an already learned motor movement, i.e., "reinvest", which can lead to subpar performance (Masters & Maxwell, 2008; Masters et al., 2013), or even the sudden breakdown of the skill, i.e., "choking" (Iwatsuki & Wright, 2016). In the models explaining these phenomena, anxiety takes a central role (Mesagno & Beckmann, 2017), moreover, Clarke et al. (2020) identified additional psychological traits which increase the susceptibility to choking, such as self-consciousness, fear of negative evaluation, perfectionism, and perfectionistic self-preservation. Interestingly, when Oudejans et al. (2017) explored the cognitive processes before episodes of choking in music performance, they found that non-task-appropriate thoughts (worries about evaluation and other disturbing thoughts) were the most common. Nevertheless, both types of foci (over-focusing on the small segments of the task and engaging in negative thought processes) seem to steer the concentration away from the external goal of the performance, resulting in poorer performance outcomes.

Extrapolating from this, the direction of the focus of attention plays a significant role in movement acquisition and performance, and appropriately instructing students to direct their attention during various performance tasks appears to be a useful tool for music educators. There are no longitudinal studies about how these cognitive strategies can be taught and their influence on the motor learning trajectory and performance; however, evidence from S1 shows that certain types of attentional foci can be trained with specific pedagogical strategies and frequent prompting. While in S1, a maladaptive strategy (reinvestment and internal focus) was taught, it is possible that adaptive and supportive attentional strategies can also be coached.

It seems necessary to have conscious motor control in the early stages of learning (Stambough, 2017; 2019), maybe even when learning new material, but as the example of the musicians in S1 and the rich literature exploring the impact of focus of attention in motor performance show (Mornell & Wulf, 2019; Williams 2019; Wulf & Lewthwaite, 2016), excessive internal focus is not beneficial. It might further the learning process to place the attention on the tactile sensations resulting from the interactions with the instrument (e.g., the point where the violin bow and strings meet) (Allingham et al., 2021) or broaden the awareness within the body to increase interoception (Paparo, 2022). Moreover, prompting students to keep an external focus of attention during performances can be helpful in terms of reducing anxiety, choking (Oudejans et al., 2017) and reinvestment (Wulf, 2013) and can improve technical fluency and musical expressivity (Mornell and Wulf, 2019).

10. 5. Health awareness, biomechanics, and instrumental technique

The importance of the correct and healthy posture and an efficient and well-established technique in instrumental playing cannot be overstated. There is a rich literature connecting postural problems and inefficient playing mechanisms to performance-related pain and injury (Blanco-Piñeiro et al., 2017; Chan & Ackermann, 2014; Steinmetz et al., 2010) and overuse syndrome and various injuries were linked to the development of MFD as well (Altenmüller et al., 2014). Studies in this dissertation (S1; S2; S3) provided some evidence that instrumental teachers had a role in establishing negative health-related behaviours in their students: they often dismissed or neglected their student’s physical complaints of pain and discomfort and did not attend to the biomechanical quality of the instrumental technique. These missed opportunities to protect their students’ physical health and promote positive health behaviours led to lasting consequences. Considering that instrumental students are most likely to turn to their principal instrumental teachers first for advice in case of performance-related pain, injury, or discomfort (Williamon & Thomson, 2006) the teacher’s responsibility in advocating positive attitudes towards health is significant (Norton, 2016).

Norton (2016) explored the role of instrumental teachers in promoting performance-related health in the United Kingdom, starting with the teachers’ own beliefs and behaviours related to the topic. They concluded that teachers’ health-promoting behaviours were dependent on various factors, such as sex, the instrument played, and personal experiences with performance-related health problems; however, the majority of the participants in this research were interested in advocating playing-related health to their students, and many of them were already taking steps to enhance their students’ physical well-being. Furthermore, these interests and actions were rooted in the belief that as teachers, they were at least partially responsible for their students' health. These positive findings seem to contradict the experiences of the musicians in the studies (S1; S2; S3); however, it is important to note that there might be a high variability between teachers' attitudes towards health in general and the additional influence of the institutions, learning cultures, and previous personal experiences also need to be acknowledged.

Music teachers carry responsibility for developing a healthy instrumental technique, i.e., a playing behaviour which is efficient and effective, in their students from a young age. As participants in Waters (2020a) study noted, inefficiently learned technique was at the core of their performance-related problems later in their studies when the amount of practice and the demands placed on them increased. Similar issues have been reported by participants of S1: many felt that certain aspects of their technique were always flawed which hindered them throughout their instrumental studies. The notion of "healthy technique" is hard to capture given the immense variations in instruments, schools and approaches, and the anthropometric characteristics of the players themselves. However, there are some fundamental principles to which all music teachers should adhere. A well-established and efficient instrumental technique starts with the appropriate alignment of gross structures, such as the pelvis, the torso and spine, the head, and the extremities (Blanco-Piñeiro et al., 2017).

Blanco-Piñeiro et al. (2015) collected the most common postural deficits of young musicians, both with and without the instrument, and found that the overall posture was defective in 70-73% of the participants. Slumped postures and backwards-tilted pelvic attitudes when seated, and rigid postures and forward-tilted pelvic attitudes in standing positions were typical. Head and shoulder alignment was also problematic: the majority of the students projected these body parts forward. Given that most music teachers are much more focused on the musical output rather than the movements the student uses to achieve them (Chan & Ackermann, 2014; Détári & Nilssen, 2022), these unhealthy postures often go unnoticed and unchallenged, and as a result, most advanced music students play in biomechanically incorrect positions (Blanco-Piñeiro et al., 2015). Therefore, it is important that music teachers gain a basic anatomical understanding and incorporate it into their teaching to develop a capacity to prevent performance-related injuries in their students. As Hildebrandt & Nübling (2004) demonstrated, educating music teachers about how to optimise their student’s playing postures led to a significant, positive effect on their awareness regarding movement quality and alignment and enhanced the way they instructed their students. This effect was also reported by the student-participants, who found that the received instruction was more accurate and helpful after the intervention, and the teachers also attended to their individual problems in a more helpful way (Hildebrandt & Nübling, 2004).

External sources, such as various somatic approaches can also support music students to develop a healthy posture which supports their instrumental technique. One good example is the Kovács method which was established at the request of Zoltán Kodály in 1959 (Pásztor, 2021), which primarily focuses on “musical work capacity” to enhance the physical condition of musicians. The method consists of a series of somatic exercises, tailored to the specific needs of musicians, which are performed in group settings, and warm-up and cool-down routines which the musician is expected to incorporate into their daily practice. General somatic methods, such as the Alexander Technique (Valentine et al., 2022), Body Mapping (Salonen, 2018), and the Feldenkrais Method (Paparo, 2022) are also often tailored to the needs of musicians and are more and more available for conservatoire-level students. Other methods, such as Dispokinesis (Hildebrandt & Nübling; 2004) and Timani (Détári & Nilssen, 2022) were constructed specifically for musicians, based on the unique motor patterns and postures required to play an instrument. In some institutions, these methods are built into the curriculum to make it more available for conservatoire-level students. The benefit of including somatic methods and other health-promoting modules in educational programs is that it raises awareness of the existing problems, informs, and provides resources for young musicians. Unfortunately, these programs are primarily tailored to professional education, and similar health-promoting initiatives are largely missing on a beginner level. Given that the foundations of instrumental technique and associated postures are laid down at the beginning of the studies, it would be crucial to include health promotion on these levels as well.

Despite these efforts, and the increased awareness of musicians' performance-related issues, the number of injured musicians is still exceedingly high. According to a recent review, 62-93% of professional musicians suffer from musculoskeletal complaints at some point in their lives (Kok et al., 2016), and these problems are already prevalent in the educational setting: Cruder et al. (2020) reported that 65% of the surveyed music student population in Europe had painful musculoskeletal problems. Overuse syndrome and musculoskeletal injuries put students at risk for developing MFD as well (Altenmüller et al., 2014); therefore, these numbers are alarming in terms of MFD prevention as well. Moreover, problems appearing so early in the career are particularly worrisome, since it might be a precursor to the rest of the musicians' careers in terms of health and wellbeing. Perkins et al. (2017) call for "radical scrutiny of the cultures of conservatoires" and an "assessment of how these can be modified to best optimize students' health and wellbeing" (p. 1).

They identified various enablers and barriers and it appears that the principal instrumental teacher and the way they communicate the importance of performance-related and general health is significant in terms of the health awareness of the students (Perkins et al., 2017). The characteristics of the environment also have a significant impact on health-related behaviour. Some participants in Perkins et al.'s (2017) study identified stress stemming from competitiveness, negative performance feedback, and workload as primary barriers to optimal health. They also highlighted that performance-related injuries are still stigmatised in the community, similarly to professional environments (Ackermann, 2017) which leads to reluctance in communicating one's issues. Tertiary music institutions have been described as a highly stressful and isolating environment, further burdened by authoritarian teaching styles and perfectionism (Demirbatir, 2015), which signals the necessity of institutional changes. However, as Duffy (2013) articulates, change in the traditional culture takes time and deliberate effort of institutional leaders as well as the teachers themselves. The music students themselves can also be powerful allies in this change: there is raising awareness of performance-related health among them, and various studies have shown that young musicians participating in higher education are increasingly open to learning more about how to protect their health during their studies (Ioannou & Altenmüller, 2015; Perkins, 2013; Stanhope, 2018).

In summary, music educators and institutions are in a strong position to contribute to preventative efforts regarding MFD and other performance-related problems (Norton, 2016). Potential tools include introducing health-related programs into the curriculum, inviting somatic teachers to educate students in body-oriented methods, and providing teachers with workshops and educational materials about basic anatomic concepts. As seen in the studies in this thesis, musicians who are affected by MFD were not provided with the appropriate support in terms of their performance-related health and health in general, and they built their health-related belief system based on their educational experiences. Thus, it is possible that with the right level of support and available knowledge, at least some of the MFD cases can be prevented.

10. 6. Conclusions

While genetic predisposition and innate personality traits are at the core of developing MFD, the role of the educational experience in aggravating or even inducing risk factors cannot be overlooked. Music teachers, knowingly or unknowingly, teach much more than just instrumental technique and musical expression; they also influence how the young musicians' self-concepts, belief systems, self-efficacy, attentional focus, motivation, and practice strategies develop, and all of these have a significant impact on the motor output. Moreover, these early experiences are likely to inform the musician's attitudes towards their practice, performance, musicianship, and careers throughout their life.

In the past decades, both researchers and music educators are striving for a better understanding of the process of instrumental learning and taking initiatives by establishing health-promoting programs and raising awareness of performance-related problems with the goal of creating a better educational environment and a healthier generation of young musicians. It is imperative to continue these programs and in addition, to exploit the most recent findings in the field of movement acquisition and performance.

Chapter 11. Conclusions

11. 1. Future directions

The presented thesis is only a first, exploratory step towards a more holistic understanding of MFD, both in terms of pathophysiology and treatment. It touched on many different topics, all of which are worthy of a deeper, more detailed inquiry. The role of the psychosocial environment in the development of the condition, especially the most influential social actors, such as parents and music teachers, is one of these, previously not elucidated topics. There are some very recent initiatives to explore the potential impact of rearing and childhood experiences (Alpheis et al., 2022; Schneider et al., 2021); however, this thesis is the first to examine the quality of the music education dystonic musicians received and its role in the aetiology. Further research is needed to refine the concepts and frameworks presented here and to develop and validate appropriate measurement tools to quantify them.

Viewing the onset of the MFD as an endpoint of a long deterioration in terms of psychological states and behaviours and researching the developmental trajectory of the condition could significantly further the field. Understanding the deeper reasons behind the cognition, emotions, and actions of musicians with MFD would contribute to our understanding and it could also generate a more compassionate and empathetic perception of these individuals. To reach this goal, it would be useful to exploit various frameworks and theories from social sciences and developmental psychology and lead interdisciplinary research into the belief systems, self-concepts, history, and behaviours of musicians with the disorder. Furthering this research would also aid the development of a more holistic treatment strategy and could identify therapeutic approaches which are appropriate to support these musicians.

Enhancing the currently available treatment strategies is imperative due to the low success rates. As the findings of this thesis show, in many practices, a wide variety of tools are used to address the musicians' non-motor problems; however, there is no available research that documents or assesses the efficiency of these strategies. There are many musician-coaches with rich personal and teaching experience leading successful studios, but their expertise is largely neglected in the literature. Probing these rehabilitation processes could potentially enhance all types of behavioural therapies led by researchers and medical professionals. To have a broader, more holistic understanding, and to build a more reliable framework for treating MFD, it would be important to include everyone who is furthering the understanding of MFD and refining the therapeutic approaches to treat the disorder.

The thesis also presented ideas about preventative strategies. These were mostly centred around building a physically and mentally healthy environment for musicians to learn in but raising awareness could also be an important point in this discussion. Many musicians with the disorder have no understanding of what is happening to them; thus, they cannot access potential support. I would argue that at least college-level teachers should have some concept of the existence of MFD to support student-musicians and understand how the development of a healthy technique and constructing an appropriate learning space can serve as protective factors against the condition.

It might not be possible to completely eradicate the disorder, but I believe that with the right research and practice, it is possible to significantly reduce the number of cases among the musicians of the next generation.

11. 2. Final remarks

This thesis provided a new, holistic model of MFD, built based on Engel's (1977) biopsychosocial model and by employing systems thinking (Ahn et al., 2006a). The epistemological and methodological approaches chosen for this research placed the musician as a person in the centre of the focus rather than the symptoms and their neurological and genetic origins.

MFD, alongside other task-specific dystonias, have remained unexplained and unresolved in the past centuries. Abandoning past theories, such as the reductionist, positivist model of the condition and taking a more holistic approach might lead us to a deeper understanding of the disorder and the musicians suffering from it, and inspire better, more effective treatment approaches, and potent preventative strategies. To reach this goal, an interdisciplinary effort is necessary, using the expertise of neurologists, physiotherapists, psychologists, music educators and coaches, and the musicians with the disorder themselves.

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Appendices

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Appendix A. Study 1. Participant information sheet

Life-stories of musicians with Musician’s Focal Dystonia: A Grounded Theory study

Background

The University of York would like to invite you to take part in the following research project: Life-stories of musicians with Musician’s Focal Dystonia: A grounded theory study.

Before agreeing to take part, please read this information sheet carefully and let us know if anything is unclear or you would like further information.

What is the study?

In the past decades, researchers tried to understand Musician’s Focal Dystonia (MFD) from a medical viewpoint and it was exclusively treated with oral medication and Botulinum Toxin injections. These strategies do not seem to be effective and have severe side effects as well. As a former sufferer and now a consultant for musicians, I am interested to find out if there are any psychological traits and environmental factors which are typical in MFD sufferers, and how they contribute to the symptoms. The main goal of the research is to understand the mindsets and thought processes of MFD before and during the onset of the symptoms, and also, how the environment influenced these individuals. This information can help to create a therapy which helps to address the non-motor symptoms to complement the physical retraining, and can also contribute to the prevention of MFD. This research is part of my doctoral studies, which I am undertaking at the University of York, Department of Music. The project has been reviewed by the Arts and Humanities Ethics Committee of the University of York (Chair: Keith Allen - keith.allen@york.ac.uk; contact: Dr Tom Collins – tom.collins@york.ac.uk)

If you choose to take part, you will be involved in this research for the duration of your interview, for approximately 60 minutes. The interview is going to be recorded (with your consent) and analysed with appropriate qualitative methods. The same process is going to be repeated with all the other participants. The themes and information which will emerge from this process will inform my Ph.D. thesis.

I want you to be aware that the topic of the interview is going to be your experience with MFD, which might cause psychological or emotional discomfort. If this occurs, you can choose not to answer the question which caused distress or even quit the interview. Also, you will be informed of the appropriate sources of medical and psychological help and the available treatments.

While there are no immediate benefits for those people participating in the project, and the researcher cannot offer payment for the participation, it is hoped that this work will enhance the current treatment for MFD sufferers.

You will be debriefed immediately after data collection, providing you with any further information that you might need in order to complete your understanding of the research. You will get access to the report of the research after it is completed through the researcher. You will not be identified in the data, nor in the report and final thesis. The data collected during the course of this research might be used for additional or subsequent research.

Why have I been invited to take part?

You have been invited to take part because of your personal experiences of MFD. Your personal knowledge is unique and valuable for my research. Apart from you, approximately 10-15 participants will be invited and interviewed during this research.

Do I have to take part?

No, participation is optional. If you do decide to take part, you will be given a copy of this information sheet for your records and will be asked to complete a participant information form. If you change your mind at any point during the study, you will be able to withdraw your participation without having to provide a reason.

On what basis will you process my data?

Under the General Data Protection Regulation (GDPR), the University has to identify a legal basis for processing personal data and, where appropriate, an additional condition for processing special category data.

In line with our charter which states that we advance learning and knowledge by teaching and research, the University processes personal data for research purposes under Article 6 (1) (e) of the GDPR:

Processing is necessary for the performance of a task carried out in the public interest

Special category data is processed under Article 9 (2) (j):

Processing is necessary for archiving purposes in the public interest, or scientific and historical research purposes or statistical purposes

Research will only be undertaken where ethical approval has been obtained, where there is a clear public interest and where appropriate safeguards have been put in place to protect data.

In line with ethical expectations and in order to comply with common law duty of confidentiality, we will seek your consent to participate where appropriate. This consent will not, however, be our legal basis for processing your data under the GDPR.

How will you use my data?

Data will be processed for the purposes outlined in this notice.

Will you share my data with 3rd parties?

No. Data will be accessible to the project team at York only. Anonymised data may be reused by the research team or other third parties for secondary research purposes.

How will you keep my data secure?

The University will put in place appropriate technical and organisational measures to protect your personal data and/or special category data. For the purposes of this project we will anonymise and pseudonymise your data and store it on password protected storage spaces.

Information will be treated confidentiality and shared on a need-to-know basis only. The University is committed to the principle of data protection by design and default and will collect the minimum amount of data necessary for the project. In addition, we will anonymise or pseudonymise data wherever possible.

Will you transfer my data internationally?

Possibly. The University's cloud storage solution is provided by Google which means that data can be located at any of Google's globally spread data centres. The University has data protection complaint arrangements in place with this provider. For further information see, https://www.york.ac.uk/it-services/google/policy/privacy/.

Will I be identified in any research outputs?

All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you that is disseminated will have your name and address removed so that you cannot be identified by it.

How long will you keep my data?

Data will be retained in line with legal requirements or where there is a business need. Retention timeframes will be determined in line with the University's Records Retention Schedule.

What rights do I have in relation to my data?

Under the GDPR, you have a general right of access to your data, a right to rectification, erasure, restriction, objection or portability. You also have a right to withdrawal. Please note, not all rights apply where data is processed purely for research purposes. For further information see: https://www.york.ac.uk/records/management/generaldataprotectionregulation/individualsrights/.

Questions or concerns

If you have any questions about this participant information sheet or concerns about how your data is being processed, please contact Keith Allen, Chair of the Arts and Humanities Ethics Committee (keith.allen@york.ac.uk) in the first instance. If you are still dissatisfied, please contact the University's Acting Data Protection Officer at dataprotection@york.ac.uk.

Right to complain

If you are unhappy with the way in which the University has handled your personal data, you have a right to complain to the Information Commissioner's Office. For information on reporting a concern to the Information Commissioner's Office, see www.ico.org.uk/concerns.

18.01.2019.

Appendix B. Study 1. Consent form

Title of Project: An investigation of the psychological background of Musician's Focal Dystonia sufferers and its possible contribution to the onset of the symptoms: A grounded theory study.

Name of Researcher: Anna Detari

Participant Identification Number for this project:

Please initial box

1. I confirm that I have read and understand the information sheet dated 12.12.2018., for the project in which I have been asked to take part and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.

3. I understand that my responses will be anonymised before analysis. I give permission for members of the research team to have access to my anonymised responses. I understand that all personal data about me will be kept confidential.

4. I understand that the investigator(s) must adhere to the BPS Code of Human Research Ethics.

5. I agree to take part in the above research project.

Name of participant	**Date**	_ **Signature**
Name of person taking consent *(if different from lead researcher)*	**Date**	_ **Signature**
Researcher	**Date**	_ **Signature**

Appendix C. Study 2. Participant information sheet

Research project title

Musician's Focal Dystonia sufferers' maladaptive psychological characteristics, behaviours and influential environmental factors from the therapists' viewpoint

Invitation paragraph

You are being invited to take part in a research project. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

What is the purpose of the project?

In the past decades, researchers examined Musician's Focal Dystonia (MFD) from a medical viewpoint, aiming to understand its pathophysiology. As a result, the most common treatment strategies are Botulinum Toxin, oral medication or movement retraining programs.

Quite recently, psychological factors have been identified as possible risk factors and triggers, alongside with some debilitative behavioural patterns and environmental factors. These patterns might have an impact on the chosen treatment as well, especially on behavioural retraining programs.

The literature suggests that medical professionals and other practitioners are aware of these problems, and in some cases even address them in their therapy, but this process is mostly undocumented. The main goal of the research is to map what particular psychological issues and connecting behaviours medical professionals and practitioners encounter in their practice, and how they handle them within the rehabilitation. This information will contribute to the final goal of my Ph.D. studies, namely to create a cognitive-behavioural therapy to complement the physical retraining, which can also contribute to the prevention of MFD. This research is the first of my Ph.D. studies at the University of York, starting in November 2018 and finishing in August 2019.

Why have I been chosen?

You have been chosen to participate in this research because of your personal experiences of MFD and special viewpoint as a practitioner. Your personal knowledge is unique and valuable for my research. Apart from you, approximately 8-10 participants will be invited and interviewed during this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep (and be asked to sign a consent form). If you decide to take part you are still free to withdraw at any time, without penalty or loss of benefits, and without giving a reason.

What will happen to me if I take part?

You will be involved in this research for the duration of your interview, for approximately 60 minutes. The interview is going to be recorded (with your consent) and analysed with appropriate qualitative methods. The same process is going to be repeated with all the other participants. The themes and information which will emerge from this process will inform my Ph.D. study.

What do I have to do?

For this research you will be asked to attend your interview, arriving at the previously set time, and stay as long as your interview is finished.

What are the possible disadvantages and risks of taking part?

I want you to be aware that the topic of the interview is going to be your personal experience of MFD patients. You will not be asked to reveal any confidential information, and you can share your professional experience and opinions to the point you find appropriate. You can choose not to answer the question if you feel it would conflict with your professional work.

What are the possible benefits of taking part?

While there are no immediate benefits for those people participating in the project, it is hoped that this work will enhance the current treatment for MFD sufferers.

Will my taking part in this project be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you that is disseminated will have your name and address removed so that you cannot be identified by it.

What happens immediately after data collection?

You will be debriefed immediately after data collection, providing you with any further information that you might need in order to complete your understanding of the research.

What will happen to the results of the research project?

You will get access to the report of the research after it is completed through the researcher. You will not be identified in the data, nor in the report and final thesis. The data collected during the course of this research might be used for additional or subsequent research.

Who has reviewed the project?

The project has been reviewed by the Arts and Humanities Ethics Committee of the University of York.

Contact for further information:

Anna Détári

ad1470@york.ac.uk

077 5393 3935

Thank you for taking part in this research project.

17.10.2018.

Appendix D. Study 2. Participant Consent form

Participant Consent Form

Title of the project: Musician's Focal Dystonia sufferers' maladaptive psychological characteristics, behaviours and influential environmental factors from the therapists' viewpoint

Name of the researcher: Anna Détári

1.	I confirm that I have read and understand the information sheet dated 17.10.2018., for the project in which I have been asked to take part and have had the opportunity to ask questions.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.	
3.	I understand that my responses will be anonymised before analysis. I give permission for members of the research team to have access to my anonymised responses. I understand that all personal data about me will be kept confidential.	
4.	I understand that the investigator(s) must adhere to the BPS Code of Human Research Ethics.	
5.	I agree to take part in the above research project.	

Participant identification number for this project:

Name of participant:

Date:

Signature:

Researcher: Anna Détári

Date:

Signature:

Appendix E. Study 2. Interview schedule

Domain	Questions
Introduction + ethics	Greeting, permission to record the interview, summary of the ethics, rapport
General information about the participant's practice	How long have you been treating people with MFD? How did you start working with MFD sufferers? Roughly how many people do you treat per year? How long does the rehabilitation last on average? How often do you see your clients/patients? How much time do you spend with them?
Non-motor symptoms	Do you notice salient psychological characteristics in the sufferers? How would you describe them? Did you notice similarities in their professional behaviour? Do your clients/patients share details about their personal/professional experience? If yes, are there any similarities between these recollections?

	Are you aware if your clients suffered any kind of psychological trauma before the onset? Are your clients/patients asked about health-related behaviour? If yes, are there frequently reported issues? Are there any other characteristics musicians with MFD share in your opinion? Follow-up questions about the topics in the framework which were not spontaneously mentioned.
The issues’ effect on the rehabilitation	What are the most important factors influencing the retraining? Subsequent questions based on the answers from the previous section: Do you think that the personality traits you mentioned influence the treatment? Do you think that the behaviours you mentioned can enhance or hinder the process?
Addressing non-motor symptoms	Do you think that the [non-motor issues mentioned by the practitioner] can be addressed as part of the treatment?

(Reported in a subsequent paper)	Do have any specific strategies to address the [non-motor issues mentioned by the practitioner]? Are there other types of therapy you suggest to them to complement the treatment?
Summary, closing the interview, ethics repeated	Asking for any last thoughts, repeated ethics, closing the interview. Thanking the participant for taking part in the research.

Appendix F. Study 3. Questionnaire items

Self-constructed questionnaire – original grouping of the items

Topic 1.	**Technique focused teaching**
	In the lessons, most of the time was spent on small segments of the technical aspects of the playing. (Technical focus)
	My teacher attempted to change my technique. (Changed technique)
	My teacher allowed me to play with my own individual technique without attempting to change it. (Own technique) Reversed
	My teacher always made me focus on musical expression. (Expression) Reversed
Topic 2.	**Body mechanics**
	My teacher never paid attention to my posture or corrected when necessary. (No posture)
	My teacher did not care if I played with a healthy technique as long as I got the notes right. (No health support)
	My teacher was concerned if I had any pain or discomfort while playing. (Concern over discomfort) Reversed
	My teacher frequently spent time explaining how to use my body when playing to avoid injuries. (Avoid injuries) Reversed
Topic 3.	**Socially prescribed perfectionism/ High demands**
	I always felt like that my teacher asked for more than I was capable of. (Too much asked)
	During my lessons, I felt I had to get things right on the first try. (First try)

	My teacher was always encouraging when I made mistakes. (Encouragement) Reversed
	My teacher always gave me time to figure out a new piece, exercise, or technique. (Give time) Reversed
Topic 4.	**Authoritative teaching style**
	I was unsure what was expected of me. (Unsure expectations)
	All aspects of the performance (e.g., dynamics, tempo, articulation) were prescribed by my teacher. (Prescription)
	My teacher's instructions were always clear. (Clear instructions) Reversed
	My teacher let me develop my own approach to each piece I played. (Own approach) Reversed
Topic 5.	**Technical problems**
	I had ongoing difficulty with certain aspects of my instrumental technique. (Technical difficulty)
	No matter how much I practised; I was still unsatisfied with some technical aspects of my playing. (Unsatisfied)
	My teacher always found a way to help me solve my technical issues. (Solving issues) Reversed
	With enough practice, I was always able to solve any technical challenges. (Self-efficacy) Reversed
Topic 6.	**Early success**
	I often played music which was ahead of my class. (Early success)
	When I started the instrument, I improved quicker than my classmates. (Quick improvement)

	Playing was relatively easy for me at the start. (Easy start)
	I entered competitions, got selected for special positions, won auditions very early during my years of study. (Ahead of class)

Items in the self-constructed scale's factors

Factor 1.	**Health and encouragement**
	My teacher never paid attention to my posture or corrected when necessary. (No posture)
	My teacher always made me focus on musical expression. (Expression) Reversed
	My teacher frequently spent time explaining how to use my body when playing to avoid injuries. (Avoid injuries) Reversed
	My teacher did not care if I played with a healthy technique as long as I got the notes right. (No health support)
	My teacher always gave me time to figure out a new piece, exercise, or technique. (Give time) Reversed
	My teacher's instructions were always clear. (Clear instructions) Reversed
	My teacher was always encouraging when I made mistakes. (Encouragement) Reversed
	My teacher was concerned if I had any pain or discomfort while playing. (Concern over discomfort) Reversed

	My teacher always found a way to help me solve my technical issues. (Solve issues) Reversed
Factor 2.	**Instrumental technique**
	In the lessons, most of the time was spent on small segments of the technical aspects of the playing. (Technical focus)
	My teacher allowed me to play with my own individual technique without attempting to change it. (Own technique) Reversed
	I had ongoing difficulty with certain aspects of my instrumental technique. (Technical difficulty)
	My teacher attempted to change my established technique. (Changed technique)
	My teacher let me develop my own approach to each piece I played. (Own approach) Reversed
Factor 3.	**Demands and authoritative teaching**
	I always felt like that my teacher asked for more than I was capable of. (Too much asked)
	During my lessons, I felt I had to get things right on the first try. (First try)
	All aspects of the performance (e.g., dynamics, tempo, articulation) were prescribed by my teacher. (Prescription)