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TOWARDS A VOCABULARY FOR DESCRIBING 3D MOTION DATA IN FUNCTIONALLY ORIENTED MUSIC THERAPY

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ABSTRACT

Functionally Oriented Music Therapy (FMT) is a special kind of active music therapy, which is focused on the neuropsychological development of patients, evaluated by the observation of the patients' motor skills and their ability to perceive and react to their environment. The rehabilitation progress is interpreted with the help of observation criteria like stability, hand function, and cross motion. In a field study we recorded three-dimensional motion data of patients with stroke and Parkinson's disease during their FMT therapy sessions. The results facilitated the development of a computer-assisted software tool supporting FMT therapists with the evaluation of their patients' rehabilitation progress. Accordingly, we transferred the FMT observation criteria, so far merely based on the personal experience of the therapists, to measurable and calculable parameters to strengthen the assessment of the therapist. The following paper will give an insight into this transfer process which was completed during the first phase of our study. The measurability of the therapy progress permits a long-term computation of the effectiveness of the whole FMT therapy approach for the first time, and the extension of FMT observation criteria with motion analysis parameters leads to a holistic view on FMT. It enables the collaboration between therapists, patients, and physicians, due to a joined assessment vocabulary. The long-term computer-assisted observation is an important contribution to explore the effectiveness of FMT and an important step towards future personalized medical care in this working field.

1. INTRODUCTION

In 1975 the music teacher Lasse Hjelm started to develop his neuromuscular therapy approach called Functionally Oriented Music Therapy (FMT). In this non-verbal therapy the therapist uses music as tool to communicate with the individually treated person, the so-called adept. Music aims to catch the adept's attention and motivates him emotionally to perceive, react, move, play, and interact. So FMT is applicable for all persons regardless of age, and is often applied to children with learning difficulties and retarded development as well as persons with neurologic or motoric diseases, e.g. Parkinson's disease or stroke. FMT merges music, rhythmical motion and breathing, healthy seating, standing and walking, bodily exercises for improved flexibility, and self-confident communication in one structured working method. This variety renders this therapy approach and its assessment parameters very valuable also for other disciplines.

As FMT refers to a tradition of over thirty years and is based on the experience and knowledge of the practicing therapists, no official assessment standards exist. The assessment parameters are derived from the main publication of Hjelm (1995), who has established FMT as therapeutic approach. As far as we know only one English publication exists about assessment methods in FMT by Persson and Smideman (2002), which defines evaluation parameters in FMT and makes them accessible for the international community. Thus many inconsistent parameters are defined depending on the various training schools for FMT, and on the therapist's practical experience. This permissive definition may result in an individual interpretation of the traditional FMT assessment criteria in daily use which diversifies the specification of the criteria. Thus the range of the rank system classifying the scale of the functional problems of an adept is different and also the estimations which functional problems match which rank on the scale. As consequence objectivity in FMT assessment cannot be guaranteed. Furthermore these criteria are only one documental instrument to describe the progress of the treated person. Due to their experience FMT therapists recognize the progress of the adepts based on video recordings of the therapy sessions, hence feeling no need to carry out the evaluation in a consistent way. The collection of the assessment parameters is rather a supplement to the much more meaningful videos recordings. Indeed FMT therapists still need to struggle for acceptance of their therapeutic approach, and they are often encountered with skepticism by physicians and neurologists. With the advent of marker-free motion sensors they seize their chance to target a more objective, computer-assisted evaluation and define additional, objectively verifiable assessment parameters concordantly.

Since we started a binational field study about motion analysis in FMT in 2012 we have been facing the task to find a common language to get our knowledge and ideas across to each other, from therapist to computer scientist and vice versa. Thus we needed to find a kind of vocabulary to extend the vaguely defined and not standardized FMT observation criteria with very clear and measurable motion parameters for subsequent motion analysis algorithms. The following paper illustrates this process by offering a current definition of FMT therapeutic tools and explaining their transfer into motion analysis. It is complemented by a description of motion studies in music therapy and drumming, and closes with a discussion of future possibilities in research and analysis of motion patterns in FMT.

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2. ASSESSMENT IN FMT

FMT is based on a holistic concept considering the concurrence of various bodily functions, such as perception, movement patterns, body control, breathing and concentration. Corresponding to its base assumption neurological disorders are reflected in a patient's behavior. The disorder could be a result of e.g. birth injuries, mental retardation, and neurologic diseases and often manifests itself in a visible anomaly or irregularity of the patient's motion. In FMT this visible deviation is called a functional constraint, because it reflects an impaired brain function: the greater the functional constraint, the lower the functional level of the patient. To observe, follow, rank, and finally treat the severity of functional problems the observation of motion is embedded in a system of specially designed observation tools, namely FMT codes and observation criteria.

2.1 FMT Codes

In a therapy session with a length of 15 to 30 minutes the therapist plays the piano while the adept plays the drums, cymbals, or various wind instruments. The arrangement of the percussion instruments is modified several times during the session, depending on the adept's functional constraints and his reactions on the supplied drum setup. Every arrangement of instruments is connected to a specific piano melody and a desired motion pattern. The motion pattern describes the sequence and order of strokes the adept has to perform, e.g. a symmetrical sequence from the center to the outer drums, or a stroke order from left to right. The combination of instrument arrangement, stroke order and melody is called a code. Within each code the therapist can vary the setup of the instruments slightly. These different versions of the same code increase the learning effect and allow for a more accurate and substantiated assessment of the functional level of the adept.

For all codes custom-made drumsticks and percussion instruments with adjustable individual stands are used. The codes can be performed in a sitting or standing position. Even special codes with longer walking distances between the drums are used. Different chairs with and without back- and armrests, exercise balls, balance pads, and cushions are also applied in order to challenge the adept's bodily skills. In addition to this technical equipment, the therapist aims to create situations that give the adept the opportunity to develop and provoke independent thinking as well as to enhance the ability to take initiative. The adept decides whether and how he follows the nonverbal signals of the therapist. His decisions are based on his capability and will to perceive and process nonverbal instructions and to react on them by means of motion, more precisely drumming or blowing.

Codes are varied during the session to practice several bodily functions and to target different cerebral regions. They are designed to address symmetrical or separate lateral motion and to improve the functions of several body parts and cognitive processing. The codes are strongly tied to the observation criteria in order to evaluate the adept's action. We will now explain these observation criteria in detail.

2.2 Observation Criteria

FMT therapists rely on different criteria to describe the bodily functions of their patients. These criteria tend to describe and evaluate neurologic functions of a patient by focusing on his bodily behavior, expressed by motion, and his ability to respond to external stimuli. So the observation criteria examine brain functions like perception, logic, memory, motor control, motor learning, and motor development. The assessment is based on the following 15 criteria, illustrated in Figure 1.

Model/logic. Model and logic pays attention to the ability of the adept to find a structure within an instrument arrangement. A structure is a repeating drumming pattern, e.g. a pattern in Western reading direction from left to right or a clockwise or anticlockwise rotational pattern. The patient should be able to derive the pattern without verbal instruction, just by trial-and-error or experience.

Perception. Perception includes auditory, visual, vestibular, tactile, and proprioceptive perception: the more impaired the overall perception, the worse the patient's ability to comprehend, distinguish, localize, disregard, and interpret the amount of incoming stimulation.

Breathing coordination. Breathing coordination is related to the ability to blow into a wind instrument and how the adept performs this action, e.g. weak or hard, in or out of rhythm with the piano. Since the therapist provides several wind instruments one after in successive order, he also analyzes the adept's capacity to reach the instruments, switch hands to receive and return them and his motoric planning of this repetitive action. In addition, breathing patterns such as rapid, slow or deep breathing or hyperventilation are registered, as well as the shape of the lips and mouth position during blowing.

Trunk rotation. Trunk rotation characterizes the ability to rotate the trunk within the horizontal plane, e.g. from left to right transverse rotation. According to Hjelm (1995) the human body consists of two functional systems: the lower system, consisting of feet, legs and pelvis, and the upper system, established by the torso, shoulders, neck, head, and arms. The two systems cooperate but also need to function separately, independently of each other.

Stability. Stability deals with the adept's ability to move in a balanced and safe way in the course of his sitting, standing, and walking action. This includes the skill to sense the floor or different underlays, like balance cushions or pads.

Hand function left and right (L/R). The development of the hands allows conclusions to the brain development, because a child learns and experiences the environment with the help of its hands. When the hand motion is limited, the brain is also not fully developed (Hjelm, 1995). Thus hand function L/R focus on the hand development in relation to the biological age, e.g. the way the drum sticks are grasped and gripped. Motor development in general grasping, reaching and postural control is described by Haywood, Roberton and Getchell (2012).

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Wrist function L/R. Wrist function describes the mobility of the wrists, hence whether the motion is executed in a stiff and unstable or flexible and soft way. Stiff motion is manifested in restricted range of motion (ROM), unstable motion in increased ROM in certain directions.

Foot and hand coordination. Foot and hand coordination deals with coordinated, simultaneous and rhythmical motion of hands and feet.

Foot L/R. The therapist pays attention to the motion of the feet while the adept is playing a feet drum. He observes whether he is able to rhythmically stomp and how he is using his feet and ankles to establish a stable sitting position.

Total coordination. The above mentioned criteria are summarized as total coordination. It considers and summarizes the motion patterns and coordination of all body parts as well as the patient's perception, stability, logic, and breathing.

Separate lateral motion. Separate lateral motion reflects the adept's ability to move his left and right body half rhythmically in a different drumming pattern.

Side difference. Side difference examines the execution of motion of the left and right half of the body, especially when the left- or right-handed adept shows an unusual dominance of one hand. Dominance can be manifested so strongly, that the adept does not use the non-dominant hand during single-handed drumming or grasping. In addition the therapist focuses on a concordant speed of the left and right hand in both-handed drumming.

Cross motion. The therapist assesses the adept's skill to overcome the median line with his hands and arms. To execute this motion the brain hemispheres need to synchronize and adopt body control by turns.

Interaction. Interaction describes the ability of the adept to react non-verbally to the therapist, to handle the musical equipment and to orientate and move within the operating space spanned by the instruments.

The criteria mentioned from *model/logic* to *foot L/R* are related to the motoric and cognitive abilities of the adept. The observation criteria *side difference*, *separate lateral motion*, and *cross motion* refer to an imaginary center line called median line, dividing the adept's body in a left and right half. Finally, *interaction* deals with the communication and contact to the therapist.

We now shortly consider the above individually mentioned observation criteria in relation to each other using the example of *trunk rotation*: A wide *perception* is based on a good functional level of the trunk to turn the upper body towards points of interest. In cases of reduced trunk flexibility, *stability* is impaired, because a mobile trunk is necessary to tare the center of mass. *Side difference* is increased with less developed trunk rotation, because the impairment passes through the anatomic chain down to the hands and feet. *Separate lateral motion* and *cross motion* are also restricted by reduced mobility in the trunk. However, the variously notable relationships and dependencies between the individual observation criteria complicate the evaluation considerably.

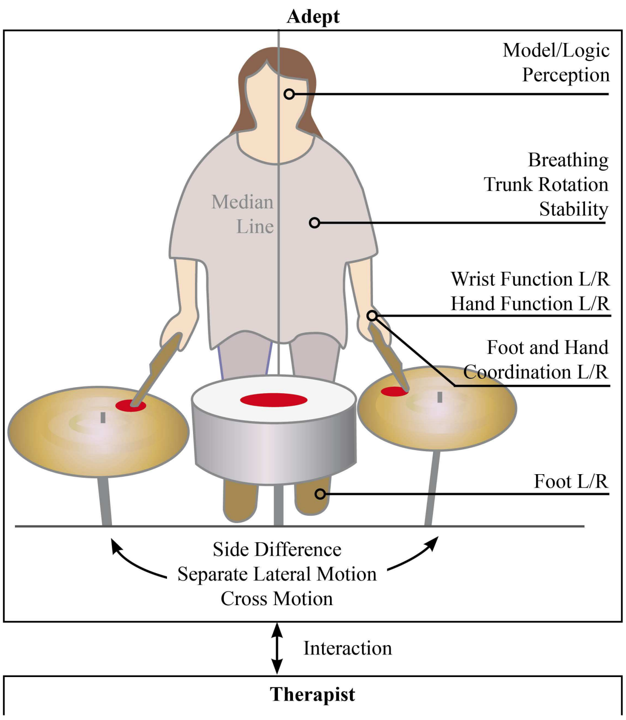

Figure 1: Schematic illustration of FMT observation criteria, except for total coordination

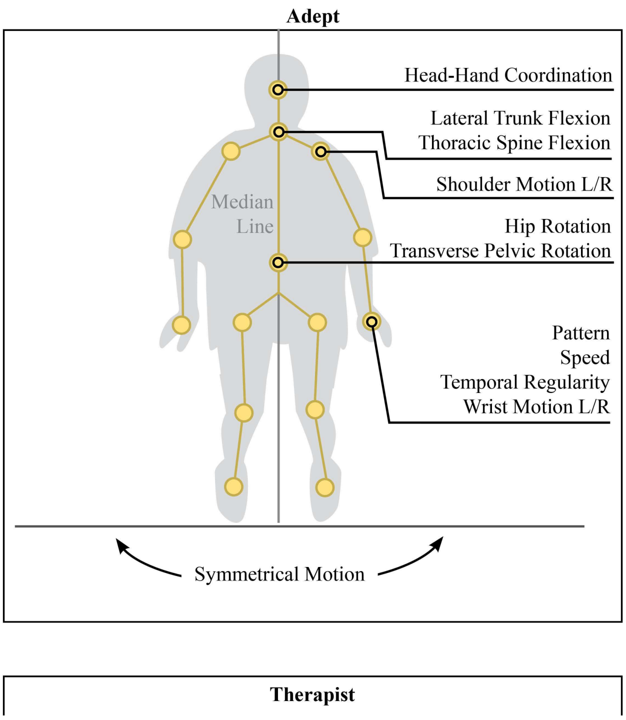

Figure 2: Schematic illustration of FMT 3D motion data vocabulary

Finally, the quality of the patient's response in all observation criteria is rated on an ordinal scale which scores his functional problems in a range from 0 - no functional problems to 6 - severe functional problems. The performance of the adept is assessed within a chosen time interval by collecting the ratings for each observation criterion and comparing them with each other. Up to now the therapists are using video recordings to document the progress of the adepts. To allow a computer-assisted evaluation in the future we need to transfer their observation criteria into measurable motion parameters.

3. TRANSFER OF FMT CRITERIA TO MOTION PARAMETERS

With the advent of low-cost hardware for motion recordings new possibilities in medicine and therapy emerged using motion data to evaluate the patient's progress. With the appearance of digital technical devices to measure and record motion, motion analysis became a possibility to examine, compare and classify motion. In our field study, we recorded motion of ten persons with Parkinson's disease and ten Stroke patients over a period of six months. A healthy control group was not involved. As recording device we used a Microsoft Kinect, which tracks the positional and rotational data of 15 joints of the adept during the FMT sessions. The resulting recordings permit for the first time to analyze the long-term therapeutic effects of FMT and facilitate new ways of presenting therapeutic progress for patients, physicians, and the therapists themselves. To render this motion data and progress depiction understandable and comprehensible for these very inhomogeneous target groups it was necessary to transfer the FMT observation criteria described in the previous section into quantitative and measurable motion parameters. In the following we would like to summarize motion studies and assessed motion parameters in music therapy and drumming. We will then present our developed 3d motion data vocabulary for FMT.

3.1 Motion Analysis in Music Therapy

Various studies in the fields of music therapy approached motion analysis. Hereinafter we would like to give an overview to motion studies aiming to analyze and evaluate the effects of music therapy or cyclic motion patterns, e.g. drumming.

Burger, Ala-Ruona and Järvinen- Lepistö (2012) traced improvements of the vertical positions of wrist and finger at an easy and difficult drumming task in FMT, illustrated in graphs and motion trajectories. Since this was a preliminary approach, a final analysis of the motion study with 45 stroke patients is still pending. In the field of neurological music therapy (NMT) Thaut (2005) gave insights in the use of Rhythmic Auditory Stimulation (RAS) to successfully treat patients with neurologic disabilities in gait. NMT also uses Therapeutic Instrumental Music Performance (TIMP), providing parallels to FMT. According to Chong, Cho, Jeong, and Kim (2013) TIMP also uses percussion instruments for the training of gross motor skills and – like FMT – it relies on different playing methods and changes in playing posture to invoke and strengthen motor patterns, "e.g., placing various sizes of drums at different heights for the player in order to induce expanded range of arm movement" (p. 421). They executed a study with 5 adults suffering from cerebral palsy (CP) assessing fine motor skills during piano play. The participants performed a repetitive play of preferred musical notes at two sessions a week for nine weeks at the maximum. In comparison to a healthy control group the CP patients slightly improved the velocity of key pressing force of the affected hand, most significantly for the index and small fingers. Schneider, Schönle, Altenmüller, and Münte (2007) found improvements in the range, speed and quality of movements of 20 stroke patients after 15 sessions of individual musical training with drum pads and a MIDI-piano. They measured the number of full cycles per second, the number of inversions of velocity and the average maximum angular velocity during whole hand tapping and index finger tapping for each hand before and after the whole treatment. They combined motion analysis with motion tests, e. g. Action Research Arm Test, and assessed improvements in everyday activities. In a follow-up study they extended their approach with EEG recordings (Altenmüller, Marco-Pallares, Münte, and Schneider, 2009).

In a motion study with four healthy drummers, Dahl (2004) investigated connections between striking velocity, preparation height and timing for different tempos, dynamic levels and striking surfaces. With the help of a 4-marker-setup and a cylindrical force plate she recorded the percussionists performing right-handed, cyclic drumming patterns with accents on every forth note. She found a close correlation between striking velocity and preparatory height of the drumstick, especially greater heights at accented strokes, and rising striking velocity with increasing dynamic level and on soft and normal surfaces. Concerning timing she traced a small drift in tempo for all players. Similar studies were conducted by Dahl, Grossbach and Altenmüller (2011a, 2011b) in slightly varied realization, e.g. extended with audio recordings, the measurement of the contact duration and with changed marker setup and tempi. Moreover Dahl, Grossbach and Altenmüller (2011b) considered motion recordings of two right-handed drummers with focal dystonia of the left arm. They discovered increased time variability at the fastest tempo of 300 beats per minute in comparison with the performance of the healthy unaffected arm and lower peak acceleration in both-handed drumming compared to healthy percussionists. Time variability and motion coordination at slow and intermediate tempi were not affected. In addition to motion analysis, rating scales and assessment tests provide methods to evaluate the bodily skills of patients. They potentially serve as tools to state the need for treatment and to estimate the effectiveness of therapy based on clearly defined exercises or items. Due to their dependence on the patient groups and application field we refer to the "Handbook of Neurologic Rating Scales" by Herndon (2006) and the Rehabilitation Measures Database (http://www.rehabmeasures.org) for assessment of patient groups similar to these in FMT.

Although approaches for motion analysis differ depending on the type of therapy and the used parameters to investigate given research hypotheses, we presented motion studies which also deal with motion analysis in music therapy or cyclic motion patterns conducted with sound. In the following chapter we introduce our 3d motion data vocabulary for assessment in FMT.

3.2 3D Motion Data Vocabulary in FMT

In FMT, motion analysis opens up new methods to arrange, classify, compare and visualize the bodily performance of the adepts. In a team of FMT therapists and computer scientists we reassembled the traditional observation criteria explained above to new meaningful and at the same time measurable parameters. In the following we will present our assessment vocabulary in FMT as well as the preconditions for the transfer of FMT criteria to 3d motion parameters and provide impulses for further research.

To transfer the observation criteria into motion data vocabulary we encounter three basic preconditions concerning the preparation, realization and evaluation of the motion recordings. In the preparation phase, limitations occur due to the chosen recording technology. Here we focused on criteria observable via motion data, whose parameters – the number of recorded joints, the accuracy and the frame rate – are determined by the used device. Additionally, the device was required to be light-weighted, mobile, low-maintenance, of robust construction and low-priced. In the realization phase more conditions arose from the concept of the FMT approach. All motion parameters needed to fit unobtrusively into the therapy sessions. They had to be recordable without voice instructions and needed to smoothly integrate into the FMT codes with percussion or wind instruments without requiring additional actions or behavior that would distract either patients or therapists. Finally in the evaluation phase, the motion data parameters demanded for intuitive and quick comprehension by therapists in their daily assessments. The analogies to their known observation criteria had to be clear, extensions and omissions obvious.

Under these preconditions motion analysis allows only a partial evaluation of all FMT observation criteria. We have chosen 6 out of 15 FMT criteria for a translation into motion analysis parameters: *model/logic*, *trunk rotation*, *stability*, *wrist function L/R*, *side difference*, *separate lateral motion* and *cross motio*n. In the following we present our 3d motion data vocabulary in FMT, illustrated in Fig. 2, as well as the connection to the traditional FMT observation criteria.

Pattern. Pattern covers the FMT observation criteria *model/logic*, *separate lateral motion* and *cross motion*. It implies the appearance of a repetitive motion pattern performed by the adept. Detected repetitive patterns are compared to a FMT code catalogue containing the different associated beat sequences. If the adept performs a FMT code correctly in accordance to the intended stroke sequence, the motion pattern is recognized and associated with that FMT code. Via this detection the pattern provides information on the adept's ability to perform *separate lateral motion* and *cross motion*, which is necessary to execute several FMT codes.

Symmetrical motion. Symmetrical motion refers to the observation criterion *side difference*. It reflects the accordance of the motion of the left and right body half, especially of the hands and wrists. Spatial symmetry is expressed by a coincident motion trajectory of the involved joints of the left and right body half, and congruent joint angles. During several repetitions, the motion ideally experiences little spatial variance and outliers. Especially the contact points of the drum sticks with the percussion instruments should be located in a narrow spatial areal in the center of the instrument.

Temporal regularity and speed. Temporal regularity and speed is related to the time-dependent aspects of *side difference*. Since the adept himself determines the speed at which he performs music codes, his chosen tempo is of high importance. Consequently temporal regularity and speed represent time-dependent motion parameters. Temporal regularity expresses the adept's ability to keep his chosen pace during the performance of one code and its versions. Pauses within a code, time-lags between the hits of the left and right drum stick, additional or missing beats and abortion of the code disturb temporal regularity. Speed describes the average drumming tempo of an adept in cycles per second (depending on the chosen FMT code and its involved number of instruments) and beats per minute. A faster or slower execution in comparison to a preferred or average drumming speed is a sign of fatigue or particular effort due to a higher degree of difficulty of the demanded drumming pattern. Parkinson patients often prefer a slower, children with ADHD a faster speed in the first FMT therapy sessions in comparison to the end of their treatment.

Ergonomic posture. Ergonomic posture specifies the FMT observation point *stability* and consists of four parts. It covers lateral flexion at the trunk, thoracic spine flexion, hip rotation around the longitudinal axis and shoulder motion during sitting. The therapist strives for an upright sitting position with no lateral flexion of the trunk. This neutral spine posture is ideally reflected in a straight upper back without any outward rounding of neither the thoracic spine area nor a postural kyphosis. The legs should be in a neutral uncrossed position with full contact of the feet to the floor and without any internal or demonstrative external hip rotation. Postures with the arm positions fixed close to the trunk need further treatment, because the adept is not able to keep a stable sitting position during flexible arm motion. The adept should be able to flex, extend, adduct, and abduct his shoulders to reach all the instruments within his reaching area. Ergonomic considerations are currently not being taken into account for standing and walking action, since some patients are using wheelchairs or walking frames and the majority of FMT codes are performed in a sitting position, depending on the functional problems of the adept.

Transverse pelvic rotation. Transverse pelvic rotation is directly transferred from the FMT observation criterion *trunk rotation*. It describes the left and right transverse pelvic rotation. An apparently reduced ROM or a motion bias in one direction demands further treatment.

Wrist motion. Since all instruments must be grasped, guided, and played with the hands, the assessment of the *wrist function L/R* is highly important. Wrist motion focuses on the ROM of the hands, especially flexion, extension and pro- and supination. During the drumming performance none of the motion angles should remain unchanged as this would be an indication for stiffness. Additionally, reduced flexion and hyperextension of the wrists adversely affect the motion, because in this case stronger arm and trunk motion is required in order to reach the drums with the drum sticks.

Head-hand coordination. This parameter is related to the mobility of the neck and the cervical spine and tries to cover partly the FMT observation criterion *perception*. It can be viewed as a simplified motion parameter for eye-hand coordination. An unrestricted motion at the neck is desired, where the head and the eyes freely follow the motion of the hands. A stiff head position without any motion at the neck, and a motion with remaining lateral bend or neck extension needs further treatment.

The remaining FMT criteria have not been involved into the 3d motion data vocabulary and open up opportunities for future research. *Perception* is difficult to assess quantitatively, because it is a compound factor of several sensations requiring many devices for the recording of all incoming stimuli. For continuous computer-assisted evaluation in FMT it would require too much effort. While we have omitted to collect data on the adept's *breathing coordination*, there are now methods available to unobtrusively document the breathing rhythm with the use of a laser-based active triangulation sensor (Bauer et al., 2012) or a Microsoft Kinect sensor (Noonan et al., 2012). In addition, finger tracking SDKs are available, allowing for computer-assisted assessment of the finger position and grasping gestures in the future and permitting analysis of *hand function L/R*. However Robertson, Vink, Regenbrecht, Lutteroth and Wünsche (2013) currently criticize the low tracking performance of finger tracking SDKs on a mid-range computer without a graphics card. We here point out that portable computers with on-board graphics are the devices predominantly used by FMT therapists. The robust recording of rhythmic feet motion due to the observation criterion *feet L/R* as well as *foot and hand coordination* highly depends on the position of the Microsoft Kinect sensor. During the recording sessions, we focused on a stable tracking of the upper body and an unobtrusive, static attachment of the sensor to the ceiling in the therapy room. This setup led to missing motion data of the feet and knees, because they were mainly covered by drums and could not be tracked continuously. In future recordings, the detection of rhythmical motion of the feet might be derivable from a pressure sensor attached to the foot pedal of a drum or an in-shoe pressure measurement device. Furthermore, affordable pressure sensors could extend motion analysis concerning sitting ergonomics and body weight distribution. In addition, some information about *interaction* are probably be reproducible from the Microsoft Kinect data, using recognition of facial expressions and analysis of the person traces following DeCamp, Shaw, Kubat and Roy (2010). Easy recognition of facial expressions, heart rate and better joint recognition, e.g. tips of hands and thumbs, are amongst others announced for the Microsoft Kinect version 2.0 (Heddle, 2013; Wired, 2013).

4. CONCLUSION AND FUTURE WORK

In the previous chapters we presented the FMT therapy approach, its working methods, and assessment criteria. With the transfer of the FMT criteria to known and understandable motion parameters we have established a scientific basis to objectively assess and evaluate the therapy progress and created an additional unifying assessment vocabulary for FMT therapists, physicians, and patients. We introduced this type of neuromuscular therapy to the general public, especially to physicians and neurologists. Its structured design builds on codes and its multifunctional assessment features, involving sitting ergonomics, rhythm, logical patterns, and mobility of the pelvis and wrists, make it highly valuable for patients with impaired brain and bodily functions. Additionally, healthy people are invited to challenge themselves and practice their postural control, separate lateral motion, and ability for logical deduction in a playful, motivating manner in FMT sessions.

Currently the development of computer-assisted motion analysis in FMT is limited to the motion parameters introduced in this paper, and their possibilities for comprehensible and clear visualization. In the beginning of our research, we agreed to deliberately restrict the number of motion parameters for reasons of clarity and comprehensibility in documentation and visualization. Further advantages consist in the facilitated familiarization with the future software and the lower expenditures in technical equipment, required disc space and working memory. However, it is still questionable whether the accuracy of the Microsoft Kinect is accepted by all target groups for all defined motion parameters. Otherwise, marker-based methods need to be provided supportively to prove the efficiency of FMT. In addition, a combination of our motion parameters with an established assessment method could be an advantage for a well-grounded study concerning the efficiency of FMT. It could allow conclusions about to what extent the measured physical changes affect the adepts' daily life and everyday actions like eating or dressing in a positive way. Thus this assessment vocabulary is a first approach for scientific discourse, which has to prove itself in practice.

We will continue with the analysis of the motion data following the above mentioned assessment vocabulary to answer the question of the efficiency of the FMT therapy approach. Our analysis of data samples indicates improvements of the adepts' functional levels, so we are eager and confident to refine our assessment approach for future application in daily practice.

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