20

Technology Developments in Music Therapy

Wendy L. Magee and Thomas Wosch

CONTENTS

20.1 Introduction to Music Therapy

Since the beginning of mankind sound and music have been used in healing (Wigram, Pedersen, and Bonde, 2002). This is illustrated through traditional healing practices such as shamanistic rituals, reflected in writings from ancient cultures spanning Arabia, Europe, and the Orient, as well as rooted in religious practices in Judaism and Christianity. Music therapy as a professional discipline in postmodern societies is grounded in developments during the 1950s in Europe, the United States, and South America. At that time, a number of models were developed by pioneers who created models using both clinical practice or theoretical contexts.

There are numerous approaches in music therapy (MT), including the Alvin Model (Alvin, 1975), Analytical Music Therapy (Priestley, 1975), the Benenzon Model (Benenzon, 1982), the Bonny Method of Guided Imagery and Music (Bruscia and Grocke, 2002), Behavioural Music Therapy (Madsen, Cotter, and Madsen, 1968), Creative Music Therapy (Nordoff and Robbins, 1977), and the Schwabe Approach (Schwabe, 1974, 2007). Each of these approaches uses music differently in interventions, which, in turn, influences how technology might be integrated into practice. However, we will draw on just two of these models as a framework for this chapter.

Analytical Music Therapy, developed by Mary Priestley in the United Kingdom, "combine(s) a psychoanalytical and psychotherapeutic understanding of the transference phenomena between the client and the therapist with the understanding of meaning and form of expressions in musical improvisations" (Wigram et al., 2002, p. 122). The musical material may be that of the client's alone (i.e., the client playing an instrument or vocalizing on her/his own with the therapist in the role of active listener), or of the client and music therapist together (i.e., the client sings and/or plays an instrument in dialogue with the therapist who sings and/or plays an instrument). In Analytic Music Therapy, the client actively makes music through improvising "in a totally free way … (that) requires no musical ability or training, and is not evaluated according to musical criteria" (Wigram et al., 2002, p. 131). This method is called "Free Improvisation" in which the client can shape sounds him or herself, thus increasing the resources and strengths of client. The music therapist supports these developments in sharing "an empathic and sensitive musical frame" (Wigram et al., 2002, p. 132). Behavioral Music Therapy, developed by Clifford Madsen in the United States, is grounded in behavioural therapies. In this approach, music is used entirely differently "… (1) as a cue, (2) as a time and body movement structure, (3) as a focus of attention and (4) as a reward" (Madsen, 1999). This approach includes high complexities of human behavior, and it is mainly based on learning principles (Madsen, 1999).

This brief overview about the beginning of modern MT illustrates that it is a highly diverse and plural therapy in its grounding and the types of interventions. Thus, a single definition of MT needs to be comprehensive to reflect different models and cultures. The World Federation of Music Therapy states that it is "… the professional use of music and its elements as an intervention in medical, educational, and everyday environments with individuals, groups, families, or communities who seek to optimize their quality of life and improve their physical, social, communicative, emotional, intellectual, and spiritual health and well-being. Research, practice, education, and clinical training in MT are based on professional standards according to cultural, social, and political contexts" (World Federation of Music Therapy, 2011, para 2). However, a common theme is that interventions are grounded in person-centered concepts to improve a client's health and well-being. Music is created and applied in these interventions in different methods. The client and therapist create and make music together in dialogue. This can be recreating a song that is familiar and meaningful to the client or creating an improvisation together. The therapist guides a therapeutic process for the client to support and change the client's perception, self-esteem, emotional experience, behavior, coping, social, motor, communication, or cognitive skills. Moving to music, listening to music (known as receptive methods), writing a song or a song text, and drawing to music are all possible. The most commonly used tools in all these methods are acoustic musical instruments and human voice. The use of technology in MT is less frequently described and thus, less understood. However, using technology in MT is a novel and growing perspective for MT.

Today, MT serves almost all fields of health, education, and social services across the life span. Its application starts in neonatology and ends in dementia care and palliative care. Music therapy serves people with developmental needs (Hintz, 2013), with mental health needs (Eyre, 2013), with social disorders and needs (e.g., Stige and Aarø, 2012), who have medical needs (Spintge, 2012), with neurological disorders (Magee, Clark, Tamplin, and Bradt, 2017) or disorders of ageing (Ridder, Stige, Quale, and Gold, 2013), or who are facing crisis caused by war or other societal traumas (Heidenreich, 2005). In the last two decades, there has been a steady growth in research and the development of evidence-based interventions in MT reflected by the number of outcome studies of MT interventions (Geretsegger, Elefant, Mössler, and Gold, 2014; Mössler, Chen, Heldal, and Gold, 2011).

20.2 Indicators for Using Technology in Music Therapy: Why Use Technology in Music Therapy?

Music therapy intervention seeks to involve both the client and therapist exploring sounds and music together as active agents of music making in interactive dialogue. Acoustic musical instruments (e.g., pitched and non-pitched percussion, piano, guitar, and other stringed instruments) and the human voice are central to this practice. That is, the client will typically be vocalizing/singing or making sounds on an instrument, and the therapist simultaneously uses her/his voice or instrumental sounds to frame, develop, challenge, or support the client's musical gestures and sounds. However, when working with people with complex motor or sensory needs, "traditional" acoustic instruments such as those listed are often considerably unresponsive or just simply inaccessible. Using acoustic instruments, small or inconsistent or weak movements can result in inadequate sounds or sounds that lack aesthetic qualities. Worse still, the client's physical efforts (that are often considerable) may result in no sound at all. Although music is a highly motivational tool to use in therapy, a lack of musical reward after the enormous physical effort required to play an instrument can be highly demotivating. Similarly, sensory problems, particularly pain caused by conditions such as burns, may limit the range of music instruments that can be used to produce a full and satisfying musical sound.

When working with people with motor and sensory needs, electronic and digital music technologies provide greater success in making sounds and a wider choice of sounds to be generated. Electronic and digital music technologies encompass a range of electronic music-making devices (e.g., electric pianos or drums), music software that may or may not be activated through assistive devices such as switches or sensors, digital apps that create music, and music recording and listening devices (Krout, 2014). All of these will be discussed in more detail later. Enabling a choice of sounds is crucial to success in using music in therapeutic interactions. The sounds and music generated should be developmentally and culturally appropriate so as to optimize client motivation. That is, the sounds or music produced should fit the person's musical identity taking on board her/his preferences for music genre, ethnicity, age, and social identity (Magee, 2014b). Most importantly, two important criteria guide decisions in music technology: access and sensitivity. If technology enables the client access to being an active agent in music making more than acoustic instruments, it is clearly indicated. Furthermore, technology is also indicated if it enables the client to produce a more satisfying and aesthetically pleasing sound.

20.3 An Overview of Technologies Used in Music Therapy

The array of music technologies that fall within the given definition of assistive technology (AT) used in this book (World Report on Disability, 2011) is vast. Some of these technological musical instruments require external assistive devices to activate sounds and others have built-in features that function as assistive devices. Assistive devices provide an interface for a person to interact with the equipment that she/he wants to use and function to enhance the person's independence in achieving a task. However, the very nature of electronic music instruments (e.g., electric keyboards and guitars, drum machines) qualifies these as "assistive technology" given that amplification is used to detect tiny manipulations on an instrument that has undergone some modification already for a nondisabled population. Five categories of music technologies are commonly used in health, education, and community settings: (i) self-contained devices that create musical sounds; (ii) devices for recording music; (iii) devices for listening to music; (iv) software for music composition, arranging, notation, improvisation, and sequencing; and (v) a number of other additional devices (Krout, 2014). Music technologies are used with people across the life span (Magee et al., 2011), ranging from neonates (Cevasco, 2014), through children (Lindeck, 2014), adolescents (Martino and Bertolami, 2014), young adults (Adams and LaJoie, 2014), and older adults (Kubicek, 2014). The range of populations and settings in which music technology is used in MT is similarly as vast, spanning acute medical settings, special schools, psychiatric settings, rehabilitation centers, and hospice and palliative care (Magee, 2014b; Magee and Burland, 2008). In this chapter, we will focus on technologies that are more aligned with AT including assistive and self-contained devices that create musical sounds and a number of software interfaces that have been devised particularly for single switch or eye gaze interfaces.

20.3.1 Voice Output Communication Aids

The most basic (yet effective) method of using assistive devices in MT is with voice output communication aids (VOCA) that record either a single message or a sequence of multiple messages when activated. These are widely used in Speech Therapy intervention (see Chapter 13) to lay the foundation for higher-level communication, however, are invaluable for recording musical messages within Music Therapy. Zigo (2014) describes how the use of VOCAs enables the technology user to have an active voice in MT sessions: the therapist records client-specific messages on the VOCA by singing the participant's name or using spoken statements that address the client's broader communication goals (e.g., "I want to play!"). Additionally, musical motifs can be recorded onto VOCAs enabling participants who cannot access acoustic instruments to have an active part as a musician in a therapy group. As Zigo (2014) indicates, musical material can be "… recorded and rerecorded easily and instantly and the variety of sounds, rhythms, and melodies that are possible are limitless" (p. 157). Multiple message devices provide greater versatility through opportunities for sequential melodic phrases, instrumental sounds, or rhythmic patterns, thus giving the technology user a wider range of expression that is more reflective of music making.

20.3.2 Self-Contained Devices That Create Musical Sounds

This category includes tablets and other devices with touch sensitive screens as well as MIDI musical instruments including several special instruments that have been developed particularly for populations with special needs. MIDI is an acronym for *music instrument digital interface.* MIDI is a standard that describes the capability of a musical instrument to connect electronic musical instruments and computer equipment. It enables information about music specific parameters (e.g., instrument sound; volume; pitch) to be transported digitally. Two electronic musical instruments in particular are useful with MIDI interfaces: the electric piano and the electronic drum kit. Both these technologies have been modified from their original acoustic forms to provide interfaces that are well suited to differing physical abilities, such as movements that are limited in the range of motion or strength. Thus, the digital instruments are more sensitive than acoustic ones.

Touch sensitive screens have similarly revolutionized the way that music can be made within MT sessions for people with complex needs. The vast array of apps available for both android and iOS platforms meet the criteria to appeal to people across the lifespan (Magee et al., 2011), and many of these are suitable for solo leisure activities. Rather than game-oriented apps, the most useful apps for MT intervention are those that can enable the client to play instrumental sounds in a similar manner as they would play an instrument. Many of these play musical sounds that enable the app to be treated like an instrument, for example, percussive sounds, sounds of familiar acoustic instruments, and sounds that mirror synthesized electronic sounds. It is the touch sensitive nature of the screens in particular that enables access to many people who previously could not be an active agent in music making owing to movements that are considerably weak, considerably small, or unable to perform "activate and release" movements that are required of most traditional musical instruments. Lightweight hand-held technology devices with shallow depth and small screens enable optimal positioning to meet a range of needs. With the myriad of music-creating apps that are available, it is possible to produce sounds of excellent quality that are aesthetically satisfying even with minimal activation. Most importantly, people with no musical training gain immediate access to music making, even with severe physical limitations that normally would inhibit the ability to do so.

A number of self-contained music-creating devices with controllers have been developed particularly for people with different needs. The MIDICreator (http://www.midicreator-resources.co.uk) is a sound module and generator that is activated through a range of external controllers including mechanical and proximity switches. The musical sounds generated include preprogrammed musical patterns and individual musical sounds. Midicreator is particularly useful when working with people with complex physical needs (Lindeck, 2014). The Soundbeam (http://www.soundbeam.co.uk) is another self-contained music generating device that uses sensors that emit ultrasonic beams, which, when interrupted, are translated into sounds. It also comes with preloaded soundsets that span a wide range of musical idioms, and can generate an endless option of instrumental sounds using an external sound module. It has been found useful with a number of populations including children with complex physical needs (Lindeck, 2014) and sensory needs (Martino and Bertolami, 2014), as well as for children and adolescents with emotional disorders (Krout, 1994).

20.3.3 Music Software Activated by Assistive Devices and Eye Gaze Technology

Several software packages have been devised particularly for people who use single switches or eye gaze technology that prove particularly useful in the MT setting. Regular music software programs for music composition (e.g., Cubase, Logic, and even Garageband) are powerful software applications for composing and recording. However, the software remains inaccessible for single switch users. Typically people using single switches have one single active movement through one field (i.e., vertical or horizontal) that is used to activate an AT device, for example, an eye blink, a single breath exhalation, a thumb or finger movement that is small, a hand squeeze, head tilt, or jaw movement. As the range of the person's movement typically does not encompass movement through two fields (i.e., vertical and horizontal), the use of more typical devices, such as the computer mouse, keyboard, or joystick, cannot be supported. Most music software relies on access through mouse or keyboard. The heavy level of dependence for people with extremely complex needs highlights the need for software for single switch users in MT to allow a client "the opportunity to independently create music without assistance" (Nagler and Lee, 1989, p. 228).

The exclusion from a school music program of students who relied on technology to access the curriculum prompted assistive technologist Jon Adams to develop several music software programs particularly for single switch users at Massachusetts Hospital School in Braintree, MA in the early 1990s. These programs enabled the students to become active participants in the wide range of school music ensembles offered, including band, rock ensemble, and hand chime ensemble. This accessible software, from the "Switch In Time" range, produces musical material through switch activation that varies in complexity, from creating a single "electronic tone bell" sound or a specific chord within a designated place in music ensembles, to musical material that is less time specific, enabling improvising music with dynamic sound and pitch assignments (Adams and LaJoie, 2014). The success of these music programs enabled young people with special needs to form a "switch section" of the school band. Furthermore, the ensuing ensemble "The Headbangers" led to switch-user music ensemble performances off campus and offered the students opportunities to gain fame as part of a rock band.

One further music program that is particularly useful for switch users is MIDIgrid (http://midigrid.fullpitcher.co.uk/). MIDIgrid presents an on-screen "grid," the cells of which can each be assigned a musical note, sound, phrase, or entire song. The musical sound in a cell is activated by selecting a specific cell. It is simple to program and allows great musical flexibility and versatility, dependent on the participant's switch use. It has been found a valuable tool for working with people with highly complex needs in MT (Kirk, Abbotson, Abbotson, Hunt, and Cleaton, 1994).

Recent years have witnessed the application of eye gaze technologies (see here Chapter 17) in combination with music technologies. The Adaptive Use Musical Instruments (AUMI; http://deeplistening.org/adaptiveuse) is a movement-to-music system with a virtual music instrument that is freely accessible online (Oliveros, Miller, Heyen, Siddall, and Hazard, 2011). It operates through interface software that is activated by eye gaze. It produces both pitched keyboard sounds and a range of percussion instrument sounds. AUMI was first developed to enable children with needs stemming from a variety of developmental diagnoses successful access to and full participation in music making in a drum class in school settings. Since then, AUMI has been incorporated into MT interventions in rehabilitation settings with children with complex neurological disabilities to address cognitive, emotional, and motor goals (Oliveros et al., 2011). In hospital and educational settings, AUMI is just another instrument used alongside acoustic instruments to enable the children to become active agents in music making within MT improvisation.

Other musical instrument prototypes drawn on brain–computer music interfaces (BCMI) activated through eye gaze (see Chapter 17). Miranda, Magee, Wilson, Eaton, and Palaniappan (2011) report on the trial of a proof-of-concept BCMI with a woman with Locked-In Syndrome. The patient grasped the concept quickly and rapidly demonstrated skill at controlling the BCMI. Using the steady state visual evoked potential system, the user selects sections of a computer screen that correspond to musical features (e.g., melody, melodic direction) and can modify the music through altering the intensity of the gaze, as well. This case demonstrated the potential for and value of a system that can enable someone even with the most severe disabilities to create music despite severe physical limitations. The prototype has been developed further to enable small ensemble performance opportunities.

20.4 Technology in Music Therapy Assessment

Technology in MT assessment is a future perspective for the clinical practice of MT. Only a small number of MT assessment tools include technology or are completely automatized, and these assess vocal responses or musical responses on instruments. The Voice Assessment Profile (VOIAS—Storm, 2013) assesses depression in a protocol of voice exercises where the client vocalizes. The VOIAS includes technological voice measurement Using the Music Information Retrieval toolbox (MIR-toolbox—Lartillot, 2013) and the speech therapist's toolbox PRAAT (Dutch for "speaking"—Lieshout, 2003). This software generates images of and measurements of the client's voice during therapeutic vocal exercises that can be evaluated by the music therapist. MIR images display features of timbre such as "spectrum, brightness, spectral centroid and spectral spread" (Storm, 2013, p. 195) and PRAAT images display features of "pitch contour" (Storm, 2013, p. 195) of the client's voice. The findings identified depressive patterns in these images of voice graphs. However, a fully automatized assessment of VOIAS needs "… a construction of a simpler version of the psychoacoustic program based on either the MIRtoolbox or PRAAT …" and "… further investigation of the psychometric properties of VOIAS …" (Storm, 2013, p. 369).

Another music therapy assessment tool includes technological measurement of musical interaction in clinical improvisation, and it is based on the Music Therapy Toolbox. Measuring a client's musical responsiveness in improvisation is a highly time-consuming and challenging task for a music therapist, requiring repeated careful listenings to audio recordings and transcription. However, the Music Therapy Toolbox (MTTB) is software that was developed for comprehensive measurement of clinical improvisation (Erkkilä, 2007; Jonscher and Wosch, 2012). MTTB measures 20 musical features including, for example, velocity, tempo, articulation, and pulse clarity of both the client's and of the therapist's musical playing in both clinical improvisation on midi-instruments (Erkkilä, 2007) and on acoustic musical instruments (Jonscher and Wosch, 2012). This measurement of acoustic musical instruments fits current best clinical practice in MT. Technology and midi-instruments are less commonly used currently in clinical MT practice. Acoustic instruments are the traditional tools used and so measurement of wave data is both novel and important.

Figure 20.1 is one example of one musical feature (velocity, which indicates loudness or volume in MTTB) depicting 138 seconds from a clinical improvisation. The red line presents an image of the client's playing, and the blue line represents the therapist's music. The labels of "leader, follower, partner, leader, resister and independent musical behaviour" differentiate six roles within "intermusical or interpersonal relationship" (Bruscia, 1987, p. 444; see also: Wosch, 2007; Scholtz, Voigt, and Wosch, 2007; Gruschka, Wosch, Sembdner, and Frommer, 2011; Wosch and Erkkilä, 2016). In second 48 of Figure 20.1, it can be seen that the client's music becomes softer in volume, followed in second 54 by the

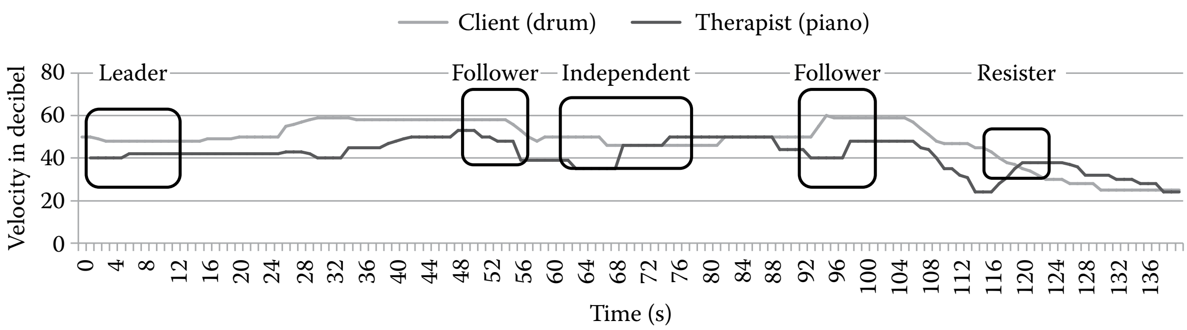

FIGURE 20.1
MTTB-interaction. (From Jonscher, A., and Wosch, T. 2012. Computergestützte musiktherapeutische Diagnostik zu Emotion und Interaktion. In *Paper Presented at the 24th Werkstatt für musiktherapeutische Forschung*, University of Augsburg; From Gruschka, K. et al. 2011. Mikrointeraktionsanalyse in der klinischen Praxis. *Musiktherapeutische Umschau*, *32*(4), 345–357.)

therapist also reducing the volume of her/his music. In this part of the clinical improvisation, the client is the leader and the therapist is the follower in the musical feature of loudness (velocity). However, velocity is only one feature of 20 potential musical features of MTTB. Ascribing a role within musical interactions, for example, of "leader" or "follower" within musical interactions, is a task for human analysis, and not a software capability. On the one hand, there is a need for an algorithm for assessing the six roles. On the other hand, there is a need for an algorithm to identify the main musical feature in each clinical improvisation. This can be based on Bruscia's "salience profile… a composite description of which musical elements are most prominent and exert the most influence over the other elements." (Bruscia, 1987, p. 441).

There are clear benefits for a client's treatment: there are a limited number of standardized assessment tools in MT, and very few of these are useful for analysis of complex music interactions that are typical in music interventions. Assessment tools in MT are largely observational tools (Schumacher and Calvet, 2007; Jacobsen, 2012). Analyzing musical interactions through behavioral observation alone is time intensive and highly complex. However, using software to analyze therapeutic music making between client and therapist provides images and detailed real-time events, all of which are invaluable for effective treatment evaluation and planning in MT. Moreover, in one case example (Scholtz et al., 2007, p. 76), the resources of a client with oppositional behavior disorder was not perceived by the music therapist, because the responses were considerably short and small. With the assessment, it is imaged (being follower in one feature) and the therapist can work with it. In this case, the assessment of considerably small details shortened the treatment of the client.

The use of technology in MT assessment and evaluation is in its infancy. However, the very promising developments described in this chapter highlight its relevance and potential to practice. In addition, the calibration of the application of AT in MT is a topic of current research and development in MT (FHWS, 2016).

20.5 Case Illustration: Incorporating Music Technology in Interdisciplinary Care of a Person with Complex Needs

The following case vignette is composited from several real life cases to illustrate how MT can contribute to interdisciplinary care of a person with complex needs, complimenting other uses of technology in such a complex case. Providing care for this type of patient typically involves direct collaboration with the team occupational therapist and speech therapist, as well as indirect collaboration with a hospital technology team involving an AT specialist, engineering, occupational therapy, speech and language therapy, and physiotherapy.

20.5.1 Client Background

The client was a 27-year old female who had sustained profound traumatic brain damage in a road traffic accident. Prior to her accident, she had completed graduate university studies and worked as a public servant. She was admitted to a specialist unit providing assessment, intervention, and long-term planning for people with complex needs stemming from acquired profound brain damage within a hospital providing neuropalliative care for adults. Owing to significant motor and cognitive impairments, she was fully dependent for all aspects of activities of daily living, had no means for communication, was fed via gastrostomy tube, and presented with fluctuating arousal for short periods only (15–25 minutes). Her capacity for language comprehension was unknown. At the time of admission to the facility 12 weeks post injury, a diagnosis of disorder of consciousness was confirmed as she was showing inconsistent behavioral responsiveness to her environment. Thus, the priority overall goal was to determine whether or not the client was aware of her environment and able to respond purposefully to her environment. People with such complex needs require assessment from treatment teams that are experienced with complexity, as motor impairments, sensory impairments, or poor motivation can often mask residual abilities. Treatment teams skilled in working with these patients understand that creative approaches are essential to ensure optimal conditions that can achieve accurate diagnosis, and thus patient-centered care.

20.5.2 Assessment

Interdisciplinary assessments using standardized measures determined that the client was most responsive within the auditory domain. Music therapy was an integral part of her treatment program from the outset to help with planning rewarding auditory stimuli to be used in interventions. Absent behavioral responsiveness to visual stimuli suggested visual impairment, and neuroimaging confirmed this with absent brain responses to visual stimuli. Interdisciplinary interventions optimized presenting stimuli within the auditory domain, and although speaking to the client fell within this scope, the client's capacity for language comprehension was unknown. The team also wanted to determine whether considerably small active movements in the client's right thumb and right foot were volitional and purposeful. If one or both of these movements were deemed volitional, then it would indicate that technology might provide a means for communication using assistive devices, dependent on whether the client also had the cognitive capacity for learning and some residual language comprehension. Purposeful object use through the ability to use a switch functionally would also confirm that the client was aware rather than having a disorder of consciousness.

20.5.3 Goals of Intervention

The team determined that a primary goal was to assess the client's ability to use a single switch with her right thumb. Her right thumb movement was able to both squeeze toward her fist and extend away from the fist. This opened up the possibility of trialing a small plate single switch to determine her awareness of cause and effect. She also demonstrated some upward flexion right-foot movements that were less consistent. Based on the consistency of her responses, the team prioritized her thumb movements. If she demonstrated awareness of cause and effect using the switch, we could explore whether we could train her to use the single switch using some type of musical reward with an ultimate goal of linking this to yes/no communication.

20.5.4 Training Switch Use

The first goal was to train the client with cause and effect using a single switch. Initial collaborative efforts between occupational therapy and speech and language therapy had introduced a small plate switch positioned between her thumb and fist, which omitted a high-pitched sound when activated. Verbal commands were used to "press the switch," that resulted in a sound, and "let go," that would deactivate the sound. Having verbal commands that resulted in a clear auditory result (sound/no sound) was essential to ensure that switch activation was purposeful and due to volitional movement rather than spontaneous movement. In this case, however, the client's responses were so inconsistent that it could not be determined if she was able to understand the verbal commands or whether the sound emitted from the switch was simply not motivating for her.

In the following sessions, MT was integrated into the treatment where we linked the small plate switch to MIDIgrid software that played the musical sounds using an external high quality speaker. We hypothesized that the musical "reward" played on switch activation would provide an opportunity to assess her use of the switch without verbal commands. It also enabled observation of her functional switch use to activate a more personally motivating auditory reward. Her sister reported that the client was an avid listener to jazz and fusion music. A single activation of the switch through thumb compression resulted in a single sustained musical chord for 5 seconds that was harmonically complex (typical of jazz idioms) played on a synthesizer timbre (sound). The chord had a relatively slow attack, meaning that it began quietly so as to avoid a startle, but then increased in volume comparatively quickly during the course of its sustain before fading. Switch deactivation through thumb release resulted in silence.

On demonstrating to the client through physical assistance how to use the switch to generate the musical chord, a change in her facial gesture and localization was instantly noted, indicative of heightened arousal and a change in affect. We gave her a verbal command to "press the switch" on one occasion to observe her independent behavior. Before we could prompt her to deactivate the switch, she spontaneously deactivated the switch as the sound was fading, and reactivated it again. On the second activation, she held the switch down until the music faded entirely. Once the sound had ended entirely, she deactivated the switch and then activated it again. She repeated this pattern four times, each time waiting for the musical sound to die out before deactivating and reactivating the switch. On the fifth activation, the music therapist vocalized quietly with the chord, adding in melodic interest. This continued for four activations in total. At this point, after eight independent activations, she stopped and seemed to be fatigued. Team assessment agreed that she had demonstrated independent functional object use through purposeful activation of the switch to play music.

In the following session, the team decided to explore whether music technology could provide a musical reward to train her foot movement and determine its purposefulness. As her movement (upward foot flexion) had limited range and strength, a different music technology was used that could meet these motor limitations better than a switch positioned with a mounting arm: we used the Soundbeam, a device that converts movements into sound through interruptions of ultrasonic pulses emitted from a sensor (Millman, 2008). It is particularly helpful when working with people with movements that are extremely limited in range of motion and strength as its settings can be programmed so that even a considerably small movement can generate a full scale (a recognizable pattern of music for most people). The client's foot movement ranged approximately 3 cm. The Soundbeam was programed, with its sensor positioned above the foot, so that the client's complete movement could potentially play the eight notes of an entire blues scale. As with the single plate switch the day before, the occupational therapist modeled the movement to the patient by assisting her foot to make the movement and generate the sound. However, we did not observe the response of recognition as we had seen with the small plate switch. The movement was assisted two more times by the occupational therapist before we observed whether the client generated the movement independently with a verbal command of "move your foot." Although there was some small movement in the foot that generated musical sounds, the client demonstrated no evidence of cause and effect. Repeated verbal commands did not elicit a response. The team assessed that the lack of somatosensory feedback for the client, owing to the Soundbeam using a noncontact sensor, failed to provide relevant feedback that could train the client in awareness of cause and effect. The Soundbeam was not deemed to meet this client's complex needs.

In the third session with MT, occupational therapy, and speech and language therapy, the goal was to provide a forum for rehearsal of switch use activated by hand movement and to continue assessment of the consistency of switch use. Thus far, the intervention involving MT had been the most successful for ascertaining consistent switch use. Again, the MIDIgrid programme was used in conjunction with a single plate switch; however, we changed the musical activity. This time, each activation of the switch resulted in a percussive sound that sustained for approximately one second. We wanted to observe her spontaneous and independent use of the switch within a music-making activity: after demonstrating the use of the switch through physically facilitating her to activate the switch so that she could hear the sounds generated, the music therapist sung and played a familiar song on the guitar. We sought to observe her activation of the switch within the music, whether she activated the switch during the music only, whether she continued to play after the music stopped, and any patterns of switch activation during the music. During the opening verse of the music, she activated the switch several times in a manner that seemed somewhat random. However, at the start of chorus (often the most familiar and emotionally stimulating part of a song), her switch activation became more regular. At the start of each measure, she activated the switch once, thus playing the first "beat" of each measure of the chorus (approximately once every four seconds). This response was important clinically, as it demonstrated her awareness of environmental stimuli (the music played by the therapist), an awareness of cause and effect (when she pressed the switch she made a sound), and a social relationship in real time (playing in synchrony with the therapist's music, at a specific point in time on repeated occasions). This continued through the next verse as well, and into the start of the second chorus during which she stopped playing, although the music played by the music therapist continued. We realized that fatigue once more seemed to prevent her playing more frequently (e.g., more than just the first beat of a measure) and for a longer duration.

20.6 Conclusions

In this case, incorporating music technology activated by assistive devices provided access to being an active agent in the therapeutic process and the music making. Traditional tools (acoustic music instruments) could not meet the client's needs in this manner. This preliminary work gave a portal through which the treatment team was able to determine that the client was aware through her purposeful and functional use of the switch. This was further supported through her nonverbal interaction within active music making (playing on the first beat of each measure) that also demonstrated awareness. Music provided a motivational medium for the client and, at a point when the team could not determine the client's residual language functioning, music provided a nonlanguage medium that enabled the client to demonstrate social awareness (playing the first beat of a measure). Music therapy provided a forum for rehearsing switch activation.

20.7 Summary

This chapter describes the developments in the field of Music Therapy concerning technology, and particularly the value of ATs for enabling independent music making in therapeutic settings for people with complex needs. Music Therapy engages an individual or group of individuals in active music making in dialogue with a trained therapist to meet goals directed at improving physical, social, communicative, emotional, intellectual, and spiritual health and well-being. When working with people with complex motor and sensory needs, acoustic musical instruments limit the person's independence and fail to respond adequately to provide optimal sounds that are aesthetically pleasing. Using electronic and digital music technologies, encompassing self-contained devices that create musical sounds, music software, and assistive devices enhances the person's independence and enables individuals with complex needs to become an active agent in musical dialogues in interaction with others. Furthermore, technology expands the repertoire of available musical sounds and possible genres, enhancing cultural authenticity in the cocreated musical events. Music software is also contributing to the development of technological assessment in Music Therapy. Music Therapy can contribute to the AT team's understanding of clients with complex needs drawing on the motivational aspects of music in combination with technology to enable a client's access to active music making within goal-oriented activities.

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