The Arts in Psychotherapy 39 (2012) 1–10

Contents lists available at SciVerse ScienceDirect

The Arts in Psychotherapy

Computer aided music therapy evaluation: Testing the Music Therapy Logbook prototype 1 system☆

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ARTICLE INFO

Keywords:
Music therapy
Evidence based practice
Evaluation
Music information retrieval
Computer
Music analysis

ABSTRACT

Research indicates that music therapists are likely to make use of computer software, designed to measure changes in the way a patient and therapist make use of music in music therapy sessions. A proof of concept study investigated whether music analysis algorithms (designed to retrieve information from commercial music recordings) can be adapted to meet the needs of music therapists. Computational music analysis techniques were applied to multi-track audio recordings of simulated sessions, then to recordings of individual music therapy sessions; these were recorded by a music therapist as part of her ongoing practice with patients with acquired brain injury.

The music therapist wanted to evaluate two hypotheses: one, whether changes in her tempo were affecting the tempo of a patient's play on acoustic percussion instruments, and two, whether her musical interventions were helping the patient reduce habituated, rhythmic patterning. Automatic diagrams were generated that gave a quick overview of the instrumental activity contained within each session: when, and for how long each instrument was played. From these, computational analysis was applied to musical areas of specific interest. The results of the interdisciplinary team work, audio recording tests, computer analysis tests, and music therapy field tests are presented and discussed.

The purpose of the proposed system is to help therapists keep track of what happens in music therapy, taking into account changes in music; so that changes in music can be objectively monitored (and quantified) in relation to other types of information, such as descriptive, written notes. The long term aim is to provide therapists with an everyday practice evaluation tool, which can be used to write session notes, record music therapy sessions, and analyse music data (Streeter, 2010, pp. 195–196).

The study follows from previous collaborations between music therapists and engineers. Since the 1990s, music therapists have made good use of computers and computational analysis to assist them in their research (Streeter, 2007). The first music therapist to trial computational analysis of music data from music therapy sessions was UK therapist, Mary Abbotson. Abbotson co-developed the Computer Aided Music Therapy Analysis prototype with engineers Dr Andy Hunt, Dr Adrian Verity, Mark Hildred, and music therapist, Felicity North (Hunt, Kirk, Abbotson, & Abbotson, 2000; Verity, 2003). In Finland, Professor Jaako Erkilla has been developing and testing the Music Therapy Toolbox system – a research tool that analyses MIDI data produced when patients and therapists improvise on MIDI instruments (Erkkilä, 2007). In Israel, Dr Avi Gilboa has been developing The Map (Gilboa, 2007), a computer based notation system for mapping music therapy sessions. In addition, Benveniste, Jouvelot, Lecourt, and Michel (2009) integrated Wii technology within a prototype digital musical instrument along with French music therapist, Edith Lecourt.

The Music Therapy Logbook approach differs from those above in that it is the first to apply computational music analysis to recordings of individual music therapy sessions in which acoustic percussion instruments were played simultaneously with a MIDI

☆ This research was supported by a Music Therapy Charity Research Fellowship awarded to Elaine Streeter, and a White Rose Health Technology Innovation Proof of Concept award to Elaine Streeter and Andy Hunt of the University of York, Joshua D. Reiss of Queen Mary University of London, Richard Caley of the Mid-Yorkshire NHS Trust and Cath Roberts of the Sheffield Teaching Hospitals NHS Foundation Trust.

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doi:10.1016/j.aip.2011.11.004

piano. The approach posed a set of technical challenges: unlike MIDI data, audio recorded from acoustic instruments is subject to interference from other sounds occurring in or around a music therapy room. However, to meet the needs of practicing music therapists it was decided to work towards delivering a system that can cope with such challenges (many music therapists prefer, or only have access to, acoustic instruments).

The focus of this paper is therefore to present the first set of test results generated by the Music Therapy Logbook Proof of Concept Study. The researchers used existing recording equipment and applied existing algorithms; these were adapted to generate information relevant to music therapy evaluation. The paper discusses the results of tests designed to find, identify changes in, and keep count of musical events across a series of individual music therapy sessions. The recording method was tested by a music therapist working with patients in a neuro-rehabilitation unit. The analysis tests were performed by a computer engineer in conjunction with a music therapist. Further research and development is necessary before The Music Therapy Logbook system can be made available to music therapists, however, initial software interface development (for Music Therapy Logbook analysis software) has been undertaken; a description of the preliminary software interface design is published elsewhere (Streeter, 2010, pp. 194–2011).

Method

Inter-disciplinary collaboration

All stages of the research required collaboration between disciplines. The team included three engineers, a clinical physicist and two music therapists. It was important to acknowledge that given the high levels of technical expertise available, computer engineering could wield more influence than music therapists' opinions. It was therefore important that music therapy was illustrated to the team via audio and video material, in order to establish the types of musical events music therapists want to evaluate.

Understandably, because engineers are not clinicians, the team struggled at first to agree the purpose of a practice evaluation tool; that it differs from that of a tool devised to assess improvement in a patient's condition. A key factor that guided the team was that music therapists set patient centred goals, but that these can range from psycho-social goals to restorative goals; for example supporting a patient through emotional adjustment to injury, as compared with helping a patient recover skills (Daveson, Magee, Crewe, Beaumont, & Kenealy, 2007). As the unifying factor across all music therapy approaches is the developing relationship between therapist and patient, it was established that the research should prove the concept of tracking musical changes that take into account the patient's musical expression in relation to the therapist's musical expression. The analysis tests were designed to answer real evaluation questions provided by working music therapists. To enhance the research, a focus group was consulted. In addition, four surveys were carried out ($n = 6$, $n = 10$, $n = 44$, $n = 125$). The results of the user opinion research are published in full elsewhere (Streeter, 2010, pp. 92–112).

Audio recording technique

A multi-channel, wireless, digital audio recording system was assembled from readily available, off the shelf products. Small contact microphones were tested; these were individually attached to each musical instrument. The microphones (with their individual transmitters) were attached in such a way as not to impede performance; for example, a microphone was attached to the inside of a snare drum head. By this means audio spill from one instrumental track to another track was limited (thus it was possible for each instrumental track to be separately analysed by the computer).

By using this method players can change instruments during a music therapy session, and move about in the normal way, without being restricted by leads or wires, or limited by the positioning of MIDI percussion instruments (which need to be conjoined with a computer). Audio signals were transmitted to a small, portable, multi-channel receiver device; this was located away from the activity area, plugged to a laptop computer. The laptop ran existing audio recording software (Ableton Live 7 was used in this instance). The sessions were therefore recorded straight to a laptop computer.

Table 1
Simulated test recordings: set 1: conga drum duet.

Improvisation number	Simulated music therapy improvisation: description
Set 1:1	Patient does not play instrument – therapist plays to patient.
Set 1:2	Patient makes fleeting sounds on drum then long silences – therapist offers musical support.
Set 1:3	Patient makes fleeting sounds, reduces silences – therapist continues as above.
Set 1:4	Patient occasionally plays unstable tempi – therapist supports patient's tempi.
Set 1:5	Patient rarely establishes tempi – but the players engage in some simultaneous play.
Set 1:6	Patient's tempo established more frequently – therapist matches patient's tempo.
Set 1:7	Patient tempo fully established and sustained – therapist sustains and matches tempo.
Set 1:8	Therapist changes tempo –\ patient does not match therapist's change in tempo.
Set 1:9	Patient initiates tempo changes – therapist responds through imitation.
Set 1:10	Patient's tempo imitates changes in the therapist's tempo.
Set 1:11	Patient plays rhythmic patterns – waits whilst therapist responds with own rhythmic patterns.
Set 1:12	Patient and therapist respond to each other's tempo changes, are able to imitate and initiate rhythmic patterns.

Simulating music therapy events

Although the music therapists were keen to stress that musical progress, of itself, cannot provide evidence of meaningful change in music therapy, it was clear that the computer engineers needed a progressive sequence of music events to test whether music information retrieval (MIR) techniques could identify and track changes in music over time. Therefore, graded examples of musical exchanges between music therapist and patient were simulated. The instructions for these improvisations were designed to illustrate possible changes in a patient's and therapist's music play over 12 weeks. One player improvised from the therapist's point of view, the other from the patient's perspective. Thus, these simulated test recordings provided idealised examples of changes in music within a music therapy relationship; for example, a patient with a fixed tempo showing awareness of a therapist's change of tempo by speeding up and matching it.

Six improvisation sets were performed and recorded. A different instrumental combination was used for each set. Set 1 required two conga drums with each player playing a separate drum. The second set involved one player performing on both conga drums, whilst the other performed on an acoustic grand piano. The remaining sets tested whether the recording technique was delivering sufficiently clean sound from specific instruments; for example a xylophone, a Sound Beam, and a guitar.

Table 1 describes the improvisation set during which the two players were limited to one conga drum per person. Each