Computer Aided Music Therapy Evaluation

Investigating and Testing

The Music Therapy Logbook Prototype 1 System

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ABSTRACT

This thesis describes the investigation and testing of a prototype music therapy practice evaluation system: Music Therapy Logbook, Prototype 1. Such a system is intended to be used by music therapists as an aid to their existing evaluation techniques. The investigation of user needs, the multi-disciplinary team work, the pre-field and field recording tests, and the computational music analysis tests are each presented in turn, preceded by an in depth literature review on historical and existing music therapy evaluation methods. A final chapter presents investigative design work for proposed user interface software pages for the Music Therapy Logbook system.

Four surveys are presented (n = 6, n = 10, n = 44, n =125). These gathered information on current music therapy evaluation methods, therapists' suggested functions for the system, and therapists' attitudes towards using the proposed automatic and semi-automatic music therapy evaluation functions, some of which were tested during the research period. The results indicate enthusiasm for using the system to; record individual music therapy sessions, create written notes linked to recordings and undertake automatic and/or semi-automatic computer aided music therapy analysis; the main purpose of which is to quantify changes in a therapist's and patient's use of music over time, (Streeter, 2010).

Simulated music therapy improvisations were recorded and analysed. The system was then used by a music therapist working in a neuro-disability unit, to record individual therapy sessions with patients with acquired brain injuries. These recordings constitute the first music therapy audio recordings employing multi-track audio recording techniques, using existing radio microphone technology. The computational music analysis tests applied to the recordings are the first such tests to be applied to recordings of music therapy sessions in which an individual patient played acoustic, rather than MIDI, instruments. The findings prove it is possible to gather objective evidence of changes in a patient's and therapist's use of music over time, using the Music Therapy Logbook Prototype 1 system.

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CHAPTER 1: Introduction

1.1. Introducing Music Therapy

Music therapy is one of the arts therapy professions regulated by the Health Professions Council UK. Music therapists work in hospitals, schools, rehabilitation centres, day care and residential care settings and in private practice. Presently there are about six hundred music therapists registered with the council in the UK. Music therapists undertake a rigorous and lengthy training; a two year post-graduate degree, preceeded by experience in a helping profession and completion of a music degree. All arts therapists regulated by the Health Professions Council will have undertaken a course of individual psychotherapy (or arts therapy) as part of their training. Hence music therapists are trained to work in depth with patients' emotional needs.

Music therapists usually work as part of a multi-disciplinary health team which together decides on, and reviews, a treatment plan for each individual patient. Each specialist will then interpret that plan in terms of his or her own practice. Referrals for music therapy are received from medical consultants, occupational therapists, speech therapists, physiotherapists, psychologists, psychiatrists, teachers, social workers and health visitors. Music therapy is used with a variety of different patient groups; studies have shown that children with communication disorders, such as autism, adults with neuro-disabilities and patients with depression are patient groups known to make particularly good use of music therapy (Hanser, 2005). Music therapy helps open up communication when patients cannot easily put their feelings into words or relate to others in positive ways. It helps focus and extend attention spans for those whose cognitive skills are limited and can enable some persons with physical disabilities to reach their potential for movement coordination (Hazard, 2008). If used systematically, music therapy may even help create new neural pathways when localised areas have been damaged (Sarkamo et al. 2008) or stimulate the development of neural pathways where such pathways are not yet properly

established, for example in pre-school children receiving music therapy for delayed developmental milestones (Streeter 2002).

Music therapists are trained to provide a safe, contained outlet for emotions and to support patients in coming to terms with their difficulties. Therapists help patients build new skills or help them reach their potential for recovery and quality of life. Very often music therapists work with patients who find it difficult to use verbal therapies either because their experience cannot be easily put into words or because they are unable to use words. Patients are seen either in small groups or individually for a series of weekly sessions over, for example a period of ten weeks.

During group sessions patients are often encouraged to engage in active music making with each other and with the therapist who provides a variety of tuned and untuned percussion instruments. Patients are also encouraged to use their voices as part of music making. In individual music therapy sessions the therapist and patient often engage in shared improvisations which evolve over time and to which they return from week to week. Sometimes improvisation is not appropriate and the therapist will use pre-composed music that either they or the patients have brought to the session; sometimes the therapist will encourage the patient group to compose their own music and to listen back to this and discuss it. Listening to music can also be part of music therapy when patients have no capacity for using instruments or when listening to music is used to stimulate memory recall or act as a catalyst for discussion.

Although there is an established body of music therapy research (Wheeler 1995, 2005,) the growth of evidence based practice in health care settings has placed particular pressure on music therapists to provide statistical evidence of the benefits of music therapy to service users at this time (Edwards, 2002). Indeed, the Health Professions Council requires music therapists to evaluate their practice not only by keeping records of each session but by analysing the evidence they have gathered (HPC, 2008). It is this writer's view that musical analysis needs to be at the centre, rather than at the periphery, of music therapy treatment evaluation when creative music making is used, as it is the use of music that distinguishes music therapy from

other types of therapy. However, as will be shown later in the study, no specialist system for gathering and analyzing music therapy evidence from recordings of music therapy is currently available; music therapists don't yet have a systematic method of objectively tracking changes in a patient's use of music over time and relating that information to existing validated outcome measures.

1.2. Introduction to the PhD Study

This thesis describes the investigation and testing of a prototype computer aided evaluation system for use by music therapists: Music Therapy Logbook. The investigation of user opinions, the multi-disciplinary team work, the pre-field and field tests and the computational data analysis tests are each presented in turn, preceded by a literature review on music therapy evaluation.

A funded proof of concept project (Streeter, 2008) allowed a multi-track recording system to be assembled and tested. The system was used to record audio signals from acoustic instruments played during simulated music therapy sessions and clinical music therapy sessions. The clinical recordings were undertaken by a music therapist working in a long stay centre for patients with neuro-disabilities. These recordings constitute the first music therapy recordings to be created using multi-track audio recording techniques. In discussion with the music therapist, computational music analysis tasks were devised to test whether her musical objectives for each of the recorded sessions had been met. The computational analysis tasks are the first such tasks to be tested on recordings of music therapy sessions in which an individual patient played acoustic, rather than MIDI, instruments. The analysis tasks were developed by the researcher together with a signal processing engineer who undertook the algorithm design. The music therapist's user needs were thus matched to existing computer coding which was adapted, in turn, to meet those needs.

During the course of the PhD study, it was necessary to keep in mind at least three different points of view; those of the therapist, the patient and the engineer. These gave rise to three questions which, although sometimes in conflict, were useful in reflecting as the project developed:

- *Is there a positive match between music therapists' opinions and the type of evaluation possible with the use of computational analysis?*
- *How can separate audio signals best be recorded at the same time so a computer can distinguish between different instruments and voices?*
- *How can the patient's playing be distinguished from the therapist's playing?*

1.3. Background to the Study

The motivation for this study arose from my extensive experience as a therapist and music therapy supervisor, and also my long experience as a senior lecturer and visiting professor responsible for training music therapists over a period of thirty years. During this time I have held a number of different academic roles; I directed two post-graduate music therapy training courses, worked as a group and individual training therapist, was a senior lecturer in music therapy, supervised trainees' clinical work and taught clinical improvisation. Between 1996 and 2005 I trained student music therapists in clinical improvisation at the Guildhall School of Music and Drama in London, where I was subsequently appointed Acting Head of Music Therapy.

In this latter role I required students to notate extracts of improvisations, primarily to map the evolving communication between therapist and client through close consideration of what was actually played when the patient was invited to improvise with the therapist. It has long been established that close analysis of such transcriptions of musical improvisations can provide a mechanism for researching issues of central importance in the musical process of music therapy (Lee, 1989, 2000) and the musical transference relationship set in motion by such exchanges (Streeter, 1999). However, when students become practitioners they often have to give up on such exercises; it takes many hours to accurately transcribe a half hour session from an audio recording of acoustic instruments. Therefore the primary data resulting from music therapy sessions (in clinical practice) all too easily becomes subsidiary to writing ward notes or session reports. This is not to criticise such adaptation to the reality of music therapy practice, it is a way of managing the overwhelming amount

of detail that could be attended to, and the multiple ways of understanding that material. The result is, however, that (for reasons which will be examined later) many therapists find themselves removed from their primary source, the music actually made, when attempting to evaluate their work. It is this writer's view that the ease by which we are able to record music should be an advantage, not a deterrent, in creating and analysing evidence of music therapy outcomes.

I was further motivated to carry out this research because I have related experience as a film composer and as an architectural designer; both these activities required technical and computing skills. Conducting orchestral scores to film requires an understanding of recording and mixing techniques, architectural training involves the use of 2D and 3D computer aided design packages. Film making and architecture entail working within a collaborative team and require a number of specialist skill sets; my past experience of collaborative projects was therefore an important factor in managing the research which expanded during the period of the PhD to encompass the funded proof of concept project (Streeter 2008).

1.4. Music Therapy Supervision Context

My current work as a clinical supervisor has also influenced this research; by describing here some issues pertaining to supervision my intention is to indicate the complexity of what it means to evaluate music therapy treatment. In the UK music therapists are required to attend supervision with a senior practitioner in order to reflect on their work. Sometimes the main consideration is the interpersonal psychodynamics of the therapy relationship between patient and therapist and how this is played out in improvised music. Another matter for discussion is whether, and how, the work may be being influenced by group and institutional dynamics within the professional setting. In addition, supervisor and supervisee may listen together to extracts of audio or watch extracts of video recordings of music therapy sessions; sometimes the pair create music together either to try out new approaches to a technical musical problem or, by using role play techniques, to enable the therapist to experience the musical dynamic from the patient's point of view. The supervision process therefore can consist of any combination of subjective observation, subjective

reflection, shared psychotherapeutic thinking, listening to or watching recorded extracts, and shared music making.

I have supervised 27 registered UK practitioners, a number of music therapists in other countries, and the clinical placements of approximately 300 post-graduate trainee music therapists in the UK. I currently supervise seven UK registered music therapists, employed by NHS Trusts and special education providers. (Supervisees attend an hour of supervision per fortnight.) By listening to music therapists discussing their work, I have become aware of the increasing gap between how music therapists 'know about' their practice and the degree to which that knowledge is transferable to health care managers whose approach to procuring services is increasingly evidenced-based. Newly qualified practitioners attend supervision regularly bewildered and quickly overwhelmed by the amount of musical data accumulated during the first few weeks of recording their music therapy sessions. Unlike students in training who reflect on work with only two or three training patients and a group, they are now faced with hours of musical material to consider with an average of 5 hours of clinical sessions per day. An example is provided by a newly qualified therapist who had practised for two months in a health authority setting for adults with a dual diagnosis of learning disability and mental illness. He was asked the question, 'What were the main challenges you faced when you started work?'

> "One of the main challenges that I faced when I started working as a music therapist was keeping track of all the music therapy material generated by my sessions. I found that I no longer had the luxury, in terms of time and energy, to just write down as much as I could remember of each session, straight after the sessions. Instead, I often had to see many clients one after another with only a short break in between sessions. This meant that I had to be much more concise and to the point in what I wrote down of each session, a few key words that could help retrieve my memory of what stood out in the sessions. Often I ended up going through all my notes from the previous session for each client, which I felt was wasteful in terms of time and energy. Lastly, all of the above difficulties were compounded in group settings, as the material generated was more complex and often more inter-relational in nature."
>
> (Wok Se Cho, 2005.)

Already evident here is a concern about how to keep track of what actually happens in music therapy. In my supervision experience, therapists quite quickly begin to reduce the number of times they record sessions. Sometimes they only record on the day they are coming to supervision, because of the impossibility of reviewing their recordings. This suggests that many music therapy interventions are failing to catch the attention of the practitioner. It is usually only the most difficult and urgent scenarios that are brought to supervision. It may take months before new practitioners bring recorded data to supervision, perhaps because by bringing one session it would put them in mind of how many other sessions they have not had time to review. This can cause a sense of disassociation from the work and confusion as to how to evaluate it.

There is a widening gap between the lived experience of music therapy and the ways in which music therapists are required to account for what happens. Because evidence based practice principles have become regulatory requirements for health practice regulators, over the last ten years supervisees have been expressing increasing concern about:

- gathering and presenting evidence for health service managers
- describing changes that have occurred, when only the evaluation of non-musical behaviours is required.
- explaining music therapy to non-musician practitioners such as doctors, nurses and psychologists in order to secure services and prevent service cutbacks.

1.5. Conclusion

The motivation for this study has therefore been influenced by my work as a music therapist practitioner, lecturer and music therapy supervisor. In addition, my previous experience as a composer and architectural designer has inspired the underlying question driving this research - is it possible to bring 21st century recording technology and computer programming into the arena of music therapy evaluation, so that objective evidence of changes in a patient's and therapist's use of music over time can help explain the benefits of music therapy?

From my own experience as a music therapist, and listening to the experiences of others, I believe music therapy can make a difference to people's lives and can help alleviate some of the conditions they have to bear. But it is no longer sufficient to merely believe such a proposition: it is time to find out whether or not it is true. At the same time as supervisees have been concerned about justifying their practice to others, as a supervisor I have been considering how a therapist might be helped to improve how they monitor their practice *before* they attempt to explain the process either to themselves or to others. These issues align with the increasing awareness of the need for systematic assessment and evaluation methods expressed by others within the profession, some of whom have made good progress in developing systematic approaches to music therapy assessment. Among these are, 'The Individualized Music Therapy Assessment Profile' (Baxter, et. al., 2007) designed for use in paediatric and adolescent settings, the MMTB (Music Therapy Toolbox) system in development at the University of Jyvaskilla (Erkkilä, 2007) and MATLAS (a music therapy assessment tool for low awareness states) in development at the Royal Hospital for Neuro-disability (Daveson, et al., 2007).

The following chapters describe a route which, of necessity, draws on multi-disciplinary knowledge. I take from each discipline only that which is necessary to answer the research questions. Where possible I have used practical means of investigation rather than theoretical discussion to deepen my awareness of the issues involved in developing a computational evaluation tool.

As music is at the core of the work, mapping changes in a patient's use of music over time has been considered central to the development of a specialist evaluation tool. However, the Music Therapy Logbook proposed in this thesis is based on the premise that objective measurements of changes in a patient's use of music over time need also to be monitored in relation to the therapist's use of music over time. Therefore the research work has taken into account both the process the therapist elicits and guides as well as the results of that process; a patient's progress in music therapy can only be maximised if therapists can identify how their own musical decisions and habits, affect the patient's ability to make use of music. Therefore, as the interaction between both parties is central to understanding what takes place, both data streams have been considered equally important.

CHAPTER 2:
Research Aims and Questions

2.1. Research Aims

The aims of the research were:

1. *To investigate the design of a prototype system that can record and quantify key aspects of a music therapy session.*

2. *Taking into account the advice of music therapists and technologists, to identify elements of recorded data it will be useful (and possible) to quantify.*

3. *To prove the concept of computational analysis for the purpose of music therapy evaluation*

2.2. Research Questions Arising

1) How do music therapists evaluate their work now?
2) What technical possibilities and limitations are encountered when considering a computer aided evaluation tool for music therapists?
3) Can a team of multi-disciplinary researchers investigate, assemble and test a specialist evaluation system taking into account the needs of music therapists? If so, what are the results of those tests?
4) What are the technical challenges that need resolution before such a system can be made available to therapists?
5) How likely is it that music therapists will want to use such a system in the future?

CHAPTER 3:

Literature Review: Music Therapy Evaluation

This section reviews the literature on evaluating music therapy practice in terms of musicianship and health care, on the use of the terms ‘evaluation’ and ‘assessment’ in the music therapy literature, on health science approaches to evaluating treatment effectiveness and assessing patient progress, and on the ways in which music therapists have researched their work in relation to music therapy practice evaluation and patient assessment. An overview of literature pertaining to the use of computer programs for evaluation is also included.

It is important to note here that the terms ‘evaluation’ and ‘research’ are sometimes confused when considering the collection and description of evidence. A distinction between evaluation and research can be made and maintained, even though the two do not necessarily define wholly separate processes. Thus, for example, although it would be unusual for clinicians to be expected to produce research as a form of evidence, they might well be expected to know the research in their field that supports and informs the methods they use to evaluate their practice. Similarly, it is important to take into account styles of research when thinking about methods of evaluation.

3.1. The Challenge of Evaluating Music Therapy as a Health Care Practice

Music therapists are concerned with how a patient makes use of music, how that use of music relates to their clinical diagnosis, how the patient’s use of music changes over time and how these changes are representative, if at all, of changes within the patients’ condition as a result of music therapy intervention. So evaluating music therapy treatment means evaluating how music is changing over time and whether or not these changes are beneficial to the patient’s health and wellbeing. This involves ascribing value to the individuality of creative acts as well as mapping that

individuality to levels of musical skill; such as playing in time and recognising and responding to time changes. Music therapists draw on two sets of skills; those concerned with musicianship and those concerned with professional health care practice. Evaluating music therapy requires an understanding of both.

On reflection, the two skill sets share commonalities: the first requires a listener to trust and rely on individual preference as well as knowledge of other unique yet related compositions or performances, while the second requires experience of previous, unique presentations of a set of symptoms (agreed as the hallmark of a specific diagnosis). However, whereas a health practitioner, in taking note of the individual presentation and timing of symptoms, is keen to match changes in these to the expected outcomes of treatment, a music listener searches out individuality of performance or composition. It is this individuality, in itself, which is often valued preferentially; an audience is unlikely to be moved by a performer or composer who cannot communicate a distinctive individuality through music.

So the task facing music therapists when evaluating their practice is complex. The music therapist must be flexible, creative and able to act spontaneously within music when responding to others, while at the same time balancing all of that with therapeutic aims and objectives. It is perhaps not surprising that, on the whole, music therapists find evaluating their work particularly challenging. This is not to say, however, that music therapists have been inactive in attempting to evaluate their work; nor have they been oblivious to the increasing importance of shared methods of systematic evaluation.

3.2. Use of the Terms ‘Evaluation’ and ‘Assessment’

In the music therapy literature it is sometimes unclear just what authors mean by these terms; do they always intend, as some authors do, a distinction between evaluating sessions (Gilboa, 2007) and assessing clients for music therapy treatment? And, more importantly, is a validated measurement scale implied when either term is used? Additionally, there is varied use of the phrases ‘test instrument’ and ‘assessment scales’, the former being used more in American English and the latter in British.

It would seem from dictionary definitions that the words ‘assess’ and ‘evaluate’ are in most instances interchangeable. Neither can deliver a definitive judgement unless the process of evaluation or assessment is matched against a scale of measurement. Hence the terms ‘evaluation scale’ or ‘assessment scale’ are used to mean that the quality, importance, amount or value of something is defined by measurements that result from tests that have themselves been put through a rigorous process of validation.

Music therapy evaluation is defined in this thesis as *‘monitoring the progress and process of music therapy with an individual’* in order to distinguish it from a validated scale of measured changes. However, aspects of assessment are included within this definition. For example, both terms appear in reflective accounts like the following: ‘*When I want to evaluate what I have done with a patient and assess the results I take time to step back from the sessions and write up a report*.’ Most therapists will want to review their work and consider how therapy will proceed as a result of such reviews. (N.B: It should be noted that although the prototype music therapy evaluation system described in this thesis is not a measurement scale in itself, one potential of this system is eventually to provide music therapists with a tool they can use to create future validated treatment outcome measures, if desired.)

3.3. Review of the Literature on Music Therapy Evaluation and Assessment.

Dr Paul Nordoff and Dr Clive Robbins began studies as early as 1964 to formulate rating ‘scales’. They later published two rating scales: Scale 1 *Child Therapists Relationship in Musical Activity* and Scale 2 *Musical Communicativeness* (Nordoff & Robbins, 1977, revised 2007). These are still in use as a means of reflecting upon work with individual children and adults. The scales are used for reviewing audio recordings of music therapy, and they provide guidelines for subjectively recording stages of progress, at least in relation to the stages of progress devised from music therapy sessions undertaken by Nordoff and Robbins in the 1960s and early 1970s. It can be argued that the so-called ‘NR’ rating scales are more descriptions of the techniques developed by Nordoff and Robbins than objective measures of changes in a patient’s use of music; thus the use of the term ‘scale’ here is potentially misleading. Notwithstanding this, the Nordoff-Robbins assessment scales offer a systematic approach to evaluation for those trained in the Nordoff-Robbins approach, helping

therapists focus their listening observations on a set of potential measures of progress—for example, noting that a child is playing in time with the therapist when six weeks prior to this there was no reaction to the therapist's tempo changes; or, with another client, noting that the client's skills have regressed.

Later work by Dr Mercedes Pavlicevic (a music therapist trained in the Nordoff-Robbins approach) resulted in the development of her Musical Interaction Rating scale (Pavlicevic, 1991). This proposes a means of identifying and describing levels of flexible responsiveness within shared musical improvisations between therapist and client. The scale outlines nine levels of responsiveness, starting with 'Level 1: No Musical Contact' and ascending to 'Level 9: Musical Partnership.' (Neither the MIR scale nor the Nordoff-Robbins Assessment scales have been externally validated.)

In the 1980s Professor Ken Bruscia devised his well-received Improvisation Assessment Profiles (IAPs) (Bruscia, 1987). Bruscia's method for analysing music therapy improvisations defines six improvisation profiles and rests on the premise that for the purpose of analysis the music is to be considered as a sound object. The system is reported to provide the user with a consistent approach to assessing *"*a continuum of five gradients or levels ranging from one extreme or polarity to its opposite" (Bruscia, 1987, p. 406). Each component of the music—rhythm, timbre, etc.—is rated separately but contributes to an overall evaluation within the particular improvisation profile being used. For example, the 'IAP 6: Autonomy' profile evaluates each musical component as a contributing factor in the changing roles assumed by each player: dependent, follower, partner, leader or resister (Wigram, 2007). The system is widely referred to in the music therapy qualitative research literature, and Wosch goes so far as to describe the method as *'*a highly differentiated instrument of measurement for diagnosis and examination of clinical improvisations' (Wosch, 2007. p. 241).

The credibility of the system has accumulated as increasing numbers of music therapy postgraduate researchers have based their own research designs on it. For example, many of the chapters in Wosch and Wigram's book *Music Therapy and Microanalysis* (2007) depend upon Bruscia's IAPs to provide a baseline for new analysis methods,

and there are many references to the work of other researchers who have used Bruscia's system.

By entering into music therapy improvisations with knowledge of pre-defined improvisation profiles, or expected stages of progress, therapists certainly face a more limited set of options in deciding which musical encounters they intend to take note of, and this perhaps would appear to make evaluation easier. However, in my experience as a clinical supervisor in the UK, practising music therapists have never reported making use of the MIR scales or the IAPs when evaluating their work, although these will have been introduced to them during training as theoretical models.

The evaluation tools described above attempt to record changes in levels of communication in music therapy. However, some therapists (particularly when trained in psychoanalytically informed methods) are sceptical about describing musical events within psychodynamic exchanges in terms of progress levels. Some music therapists prefer not to conceptualise music therapy as a hierarchical process that proceeds in a linear way through predetermined stages (Streeter, 2007). Some patients may take more steps backwards than forwards with respect to identifiable skill sets, yet during such periods of regression emotional and psychological needs may be being addressed. Not everyone referred to music therapy wants to improve, particularly when their difficulties are long established and familiar or when improvement means a small step rather than a full recovery. Indeed, it can be argued that scant knowledge of these measurement scales may even lessen a therapist's ability to value their work and engage creatively with the patient—wherever the musical encounter may lead (Streeter, 2007).

As in any relationship, who is doing the leading and who the following is a matter for debate; and for this reason, although these methods provide useful guidelines for subjective enquiry and are useful to those academic researchers who have time to engage in detailed reviews, it is questionable whether they are practical for practitioners. One music therapist (Skrudland, 2009) commented in her review of microanalysis techniques that she would first need to argue for time to do microanalysis as part of her clinical practice, before being able to engage in this kind of evaluation.

None of the methods described above has been externally validated. Over the last ten years there has been growing concern at the lack of any systematic, workable (and therefore shareable) method. For example, during the 1999, 9th World Congress of Music Therapy in Washington, DC, the research committee of the American Music Therapy Association created an 'Assessment Institute' to focus specifically on the need to develop systematic procedures. The Institute proposed two journal issues on assessment, to be edited by the *Journal of Music Therapy* (2000) and *Music Therapy Perspectives* (2000). From the papers that resulted from those calls, the Institute identified a need for more research on assessment. In the following section I review the papers most pertinent to the present research in order to identify the range of methods in use at that time.

Assessment methods reported in the Journal of Music Therapy (2000) and *Music Therapy Perspectives* (2000)

Gregory (2000) reviewed issues of the *Journal of Music Therapy* from 1984 to 1997 to investigate to what extent music therapists were using test instruments to assess their music therapy work. He found that of the 220 papers selected, 92 papers included the use of what was referred to as a 'test instrument.' A surprisingly high number of such test instruments were reported—115 in all, which suggests that many of these were individually designed. Indeed, only 40% were published tests; the others were either unpublished (35%) or constructed by the researcher (25%). For example, Edgerton (1994) devised a Checklist of Communicative Responses and Acts which she used to investigate her work with children. Gregory defined 'published tests' as those either found on the Buros Center for Testing web site or referenced in the Buros Institute's *Mental Measurement Yearbook*, *Tests in Print*, or *Test Critiques*. Of the 62 published test instruments reported by Gregory it would seem that only 15 may have included a reference to music; none of these were specific to music therapy, and none had been devised by music therapists. A recent web search of the Buros *Mental Measurement Yearbook* reveals that no specific music therapy test instruments are listed. Test instruments that refer to music fall within the subject areas of psychology; psychiatry; education; behavioural science; speech, language, and hearing. Music is mentioned in a small minority of these; an instance is the 'Am I Musical? Music

Audiation Games' test instrument (Gordon, 2005), designed to give a general estimate of the extent of music potential a child or adult possesses.

Thus, although there were 62 published test instruments used by authors in published articles in the *Journal of Music Therapy* and *Music Therapy Perspectives* between 1984 and 1997, these test instruments had not been validated to assess the effectiveness of music therapy. Of the approximately 29 researcher-constructed tests, none appear to have been tested for reliability; they were individually designed for use in personal research on the researcher's practice or the practice of other music therapists.

Wilson and Smith (2000) reviewed assessment methods used by music therapists in special needs school settings with the purpose of determining whether it would be feasible to create a standardised assessment instrument. The authors used 3 online data bases (ERIC, PsycINFO, and Article 1st) to locate articles published between 1980 and 1997. Individual hand searches were also made of *The Arts in Psychotherapy*, *Journal of Music Therapy*, *Journal of Research in Music Education*, *Journal of the International Association of Music for the Handicapped*, *Music Therapy* and *Music Therapy Perspectives*. Of 41 articles selected, 20 reported the use of a named assessment tool. However, only 3 of these 20 articles presented a study completed with the use of such an assessment tool; thus, in most instances, it was impossible to judge whether the assessment tools were appropriate to the task. A further 21 articles reported the use of untitled and usually experimentally designed, original assessment tools (Wilson and Smith 2000). A mere 6 of those 21 articles concerned a study undertaken with the use of such a tool.

This would seem to indicate that although some music therapists during this period were interested in using published assessment tools, most of the tools used were not specific to music therapy evaluation. Wilson and Smith (2000) reported that within these non-specific assessment tools the musical elements included music perception (37%), musical aptitude (29%), musical preferences (12%), and attention to/enjoyment of music (2%). Assessed non-musical behaviours or responses included self-expression (10%), motor responses (10%), behavioural responses (7%), cognitive development (2%), and acts of communication (2%). It is questionable whether 'self

expression' can be distinguished from 'acts of communication'. Regardless, however, the results show that for the music therapists who used assessment methods created by other professionals, musical perception was more frequently reported as being evaluated than musical expression at that time. This would seem to indicate that the majority of writers were American or trained in American universities, since European training courses tend on the whole to focus on expressive techniques.
In summary it would seem to be the case that very few validated scales of assessment were in use during the seventeen years studied. Of the ones which were in use, none appear to have been validated as an assessment tool designed for use by music therapists.

An important study was that of Robb (2000) who proposed a contextual support model for music therapy and, using it, was able to monitor the effect of therapeutic music interventions on the behaviour of hospitalized children in isolation. Drawing on a motivational theory of coping (Skinner and Wellborn, 1994), Robb posed the following hypothesis:

> Therapeutic music environments possess elements of structure, autonomy support, and involvement that lead children to become more actively engaged with their environment. (Robb, 2000, p.118)

Using coping as an organizational construct, Robb's study examined three suppositions: (a) that music interventions create supportive environments, (b) that music interventions increase children's active engagement, and (c) that relationships exist between supportive environments and engaging behaviour. Ten children with cancer, restricted to an isolated environment, participated in the study. The children experienced four different environmental conditions. Statistical analyses of video data revealed that therapeutic music interventions elicited significantly more engaging behaviours from hospitalized children than other hospital activities. The study was unable to show that positive behavioural effects are maintained in hospital experiences that followed music therapy sessions.

Hinzt (2000) proposed a music therapy assessment model for geriatric clients in long-term care and rehabilitation facilities. The proposed assessment format addressed five

areas: expressive musical skills, receptive musical skills, behavioural/psychosocial skills, motor skills, and cognitive/memory skills. The author argued that assessment of these areas was likely to provide helpful information about the client's tendencies to organize and process sensory data into meaningful information while engaging in musical experiences. Similarly, Scalenghe and Murphy (2000) made their own suggestions for music therapy assessment, including a ‘progress note’ that would meet managed care requirements.

Wigram (2000) went so far as to suggest that music therapy itself can provide diagnostic information and that it can play a significant role in the diagnosis and assessment of children and adults with pervasive disorders. His opinion was argued by the use of a single case study from which he analysed musical events using Bruscia's Improvisation Assessment Profiles (1987). Musical material was found to support the diagnostic criteria for autism. Nevertheless, because this study relied on a single case study, the results cannot be used to argue that music therapy assessment is an effective diagnostic approach to the assessment of childhood autism.

In contrast, Brunk and Coleman (2000) proposed the use of a standardised assessment process (rather than test) for evaluating music therapy in special education settings. They argued that as each child with special needs has a unique profile, music therapy with such children is too individual for standardised assessment techniques; rather, it is more useful to evaluate the *process* of delivering music therapy. In agreement, the Music Therapy Logbook system proposed in this thesis is directed towards establishing improved standards of practice evaluation rather than patient assessment (though attempts to construct and test diagnostic musical criteria may indeed be enabled through such a system).

Loewy (2000), using a psychotherapeutic approach with children who were attending a paediatric hospital for short stays, argued against using musical material to establish effectiveness, asserting instead that individual descriptive narratives best reflect the significance of music therapy in music therapy assessment, rather than check lists or charts:

> It is the words we assign to describe the music therapy experience that will help us interpret its significance. It is the words that will represent the clinical work in the chart or medical record. (Loewy, 2000, p. 47)

In contrast to this therapist-centred approach, the art therapist Gantt (2000) explored how the use of measurement may contribute to the formal development of assessments in the creative arts therapies. Her *Formal Elements Art Therapy Scale* (*FEATS*), designed to measure global characteristics in a particular drawing, uses variables originally selected as the graphic equivalent of psychiatric symptoms. Gantt argued that the same concepts may also be useful in music therapy assessments and that there is a need for standardized instruments in the creative arts therapies that meet the scientific requirements of reliability and validity.

Considering the range of approaches to evaluation and assessment discussed with regard to these two journal issues, it is clear that although many different approaches had been, or were being devised during the time periods reviewed, writers were united on the need for suitable assessment and evaluation procedures.

A Later Review of Evaluation Methods used by Music Therapists

A later study by Sabbatella (2004) lent weight to the view that music therapy evaluation is not standardised across the profession. Sabbatella (2004) surveyed all published articles on music therapy assessment and evaluation between 1985 and 2001. She noted that

> ...the organization of the information appears fragmented and incomplete from the point of view of clinical evaluation as a methodological process (objectives, criterion, data collection and categorization, standardization of instruments, areas of evaluation**,** relationships between assessment and evaluation, reports style, evaluation of treatment effectiveness, etc.).
>
> (Sabbatella, 2004, p.4)

She based this opinion on her review of 41 referenced papers which she categorised as follows:

- Theoretical papers (n= 21)
- Assessment and clinical evaluation of clients (n=16)
- Evaluation of music improvisation or musical behaviours related to music therapy (n=2)
- Treatment effectiveness (n=2)

(Sabbatella, 2004, p. 9)

The two reviewed papers specifically concerned with evaluating music improvisation were by Professor Suzanne Metzner, using a psychoanalytic approach and evaluating her work with adult groups (Metzner, 2000) and Professor Colin Lee, using a creative music therapy approach, and proposing a method for evaluating music therapy with individuals (Lee, 2000).

It is useful to note that only 2 of the 41 referenced papers reviewed by Sabbatella concerned 'treatment effectiveness.' The majority of published papers involved therapists theorising. However, this is not to say that music therapists were unwilling to look at treatment effectiveness but merely that since there is a dearth of outcome measures that take musical behaviours into account, music therapists are rarely able to undertake such studies. (A notable exception is Robb (2000), who proposed the contextual support model for music therapy evaluation described earlier.)

Recent Developments in Validated Assessment Methods

By 2006 two music therapists had pushed forward the possibilities for music therapy assessment in the geriatric field: the *Residual Music Skills Test* was devised to systematically identify, and therefore assess changes in, the musical skills of patients with possible or probable Alzheimer's disease (York, 1994, 2000); and the *Music-Based Evaluation of Cognitive Functioning* (Lipe et al., 2007) was devised as a method of measuring changes in cognitive function. Both these assessment tools are reported to have received construct validation, and both have been tested against the non-musical outcome measure known as the Mini-Mental State Exam (MMSE). Results of the tests revealed significant correlations between the MMSE and both these music-based assessments.

Of particular relevance to the present study are the opinions expressed by these authors that, although their test results identified strong relationships between music and general cognition, they also revealed that melodic, singing and rhythmic skills are related uniquely to the cognitive abilities of individual patients. Hence it is crucial to develop an evaluation tool, such as the Music Therapy Logbook, that therapists can use in their daily practice and that can serve as a framework for a *shared* system of evaluating progress in music therapy. It is only by taking into account the variety of musical responses found to be activated in music therapy that any future validation will be possible. It may, for instance, become clear that what music therapy does best is to stimulate a patient's ability to express themselves as recognisably individual, rather than helping them attain pre-determined progress steps.

Recent Developments in Other Assessment Methods

Baxter's recent Individualized Music Therapy Assessment Profile (Baxter et al., 2007), designed for use in paediatric and adolescent settings, further exemplifies how music therapists are beginning to devise methods that gather information about musical as well as developmental skills. By drawing both on existing standardized assessments, across child development fields, and on music therapy assessment methods, gross motor, fine motor, oral motor, sensory, receptive, communication/auditory perception, expressive communication, cognitive, social, emotional and musical skills are all taken into account when assessing the child.

A scoring system aims to produce a comprehensive profile of the client's abilities and impairments. The assessment method allows information about a given skill to be captured in different ways. For example; the skill described as 'follows two-step verbal directions' appears in the cognitive domain, the receptive communication/auditory perception domain, and the social domain. Of particular relevance to this study is the inclusion of a CD-ROM that allows the music therapist to input data from assessments into software files and therefore to track progress over time. Clearly a great deal of work has gone into the development of this tool, which speeds up the process of comparing different types of subjectively observable data.

A similarly impressive project is the evolving MATLAS system (Music Therapy Assessment Tool for Low Awareness States) developed by Daveson (Daveson et al., 2007) at the Royal Hospital for Neuro-Disability. MATLAS aims to provide music therapists with a method of assessing their patient's state of awareness by referring to musical participation and response.

Finally, the AQR (Assessment of the Quality of Relationship) evaluation scales developed by Schumacher in the course of her work with children with autistic spectrum disorders (Schumacher, 2007) draws on music therapy data as a means of assessing the ability of a child with ASD to relate to others.

Summary

This review of the literature maps the increasing interest music therapists clearly have in devising systematic, musically informed methods of assessment and evaluation. The emphasis has increasingly been to devise ways of assessing individuals in music therapy in relation to other established health care assessment methods, particularly those that have been validated against diagnostic criteria. However, perhaps problematically, each of the recent assessment systems described above differs from all the others. In his review of medical music therapy research papers Aldridge proposes that

> … standard research tools and methods of clinical assessment be developed which can be replicated, which are appropriate to music therapy and develop a link with other forms of clinical practice. (Aldridge, 1996, p.26)

The prototype system described in this thesis (the proposed Music Therapy Logbook system) differs from many of those reviewed above in that it is a system for *evaluating the practice of music therapy*, rather than a system to be used for assessing an individual. It is this author's view that by generating objectively recorded data (and using a computer to analyse that data), music therapists will be enabled to evaluate their actual practice.

If, in the future, the Music therapy Logbook were to become established as a widely used evaluation tool, consistent usage would provide access to a source of objective, and therefore diagnostically relevant, data. The data could then be used by therapists to enhance subjective observation of the ways in which different client groups make similar, or different, uses of music in music therapy. In its final form, the Music Therapy Logbook system would thus make a significant contribution towards an assessment framework that could be shared by all music therapists. It must be emphasized, however, that it has not been the intention of this research to devise a method for assessing individuals; rather, the investigation focuses on how a specialist system can best enhance existing evaluation techniques.

3.4. Music Therapy Evaluation and Evidence-Based Practice

The development of these recent approaches to assessment has been stimulated by the pressure music therapists feel to provide evidence. Assessing patients against measurable scales of behaviour or physical progress has become endemic in health care, so that for example, high blood pressure is usually treated when a person overrides the globally agreed safe level. Evidence-based practice is now very well established as the driving force behind health service provision.

> As an approach to patient care, Evidence Based Medicine is increasing its hold as the dominant approach to determining service provision in hospitals and health administrations around the world. It has influenced perceptions of the value of all patient care 'outcomes' in medical contexts, not just with reference to services provided by doctors and physicians but also allied health professions. (Edwards, 2002, p. 29)

Health-care managers need to be able to justify their financial investments with assurances that practitioners will provide the most effective way of meeting the needs of the patient populations they serve. To do this they need evidence of treatment effectiveness. The decision to implement a particular form of treatment usually falls to a medical practitioner, medical consultant, or to the considered opinion of a multi-disciplinary team. Understandably, medical practitioners require evidence that treatments provided by allied health professionals actually work. Evidence-based

medicine has come to rely on, and be driven by, research methods that deliver objective results. But as Grol & Grimshaw (2003) noted, the most consistent finding in research on health services is the gap between evidence and practice. Notwithstanding this, health economists and health science researchers very often assume that results from randomised control trials are the most effective means of monitoring treatment effects. Edwards notes that

> The two cornerstones of research advocated by proponents of EBM are the randomised controlled trial (RCT) and the systematic review or meta-analysis of the available RCTs conducted within a defined topic…. The RCT is frequently described as the "gold standard" for medical research (Kaptchuc, 2001).
>
> (Edwards, 2005, p. 294)

A recent policy statement from the United Kingdom Medical Research Council's clinical trials unit supports this view:

> Across the world, randomised controlled trials are now seen as the most reliable way to test new treatments and to compare two (or more) existing treatments, to see which one works best. (Medical Research Council, 2010)

RCT design benefits from large samples of patients in order to accommodate a control group as well as a treatment group. For example, a trial of nurse-led implementation of calcium and vitamin D supplements for fracture prevention (Porthouse et al., 2005) required participating GP practices to generate lists of women aged 70 or over and resulted in 3,400 women being recruited into the study. There were three aims to the research:

- To assess the impact of calcium and vitamin D on all non-vertebral fractures;
- To assess compliance with the supplement;
- To assess the cost effectiveness of the intervention.

A study such as this clearly benefits from using an RCT design. Since the same specific dietary supplements are being offered, differences in progress between those who had received them unknowingly and those who had not received them could be quantified relatively straightforwardly.

The emphasis on randomised controlled trials in evaluating overall treatment effectiveness poses a challenge to music therapists. Randomised control trials are often inappropriate for expressive arts-based practices that depend upon individual expression and therefore produce unique pieces of independent data that are significant in their distinctive content but impossible to replicate. However, music therapists have attempted studies using this research design, particularly when the effects of music listening are being evaluated. Indeed, a study by Brooks (2003) showed that a majority of international research papers in the English language investigating music therapy have attempted to use quantitative methods. However, many of these studies have entailed registering the effects of controlled music when played to patients, rather than the effects of originally created music when shared as an expressive act. Edwards, commented that

> "Because RCT's require standardised interventions, music therapists often find themselves using methods such as music listening for research purposes although this does not reflect the actual work of music therapists in developing a therapeutic relationship through emergent musical material." (Personal communication, 2009)

This is not to imply that music listening does not reflect the way in which some music therapists work with specific patient groups. An important recent study by Sarkamo, Tervaniemi et al. (2008) of the University of Jyväskylä, Finland, used a single-blind, randomised, controlled trial to determine whether everyday music listening can facilitate the recovery of cognitive functions and improve mood after stroke. Their findings, from a group of 60 patients randomly divided into a music group, a language group and a control group, clearly demonstrated that music listening during the early post-stroke stage can enhance cognitive recovery and help prevent negative mood. However, some controlled studies have specifically investigated expressive music therapy techniques such as those evaluated by Nordoff-Robbins scales. Of necessity

these are notable for small sample sizes, compared to those used for pharmacology trials. For example, Pavlicevic and Trevarthen's study (1989) compared the music playing of 15 depressed patients, 15 schizophrenic patients and 15 clinically normal controls with the aim of analysing diagnostic musical criteria. Although Aldridge (Aldridge, 1996, p. 62) noted that their results concerning schizophrenic patients correlated with other studies of schizophrenia (Fraser et al., 1986, Lindsay, 1980) these trials have not yet been repeated with larger participant numbers. Therefore it is difficult to draw any clear conclusions about their findings concerning diagnosis of mental health illness and music. However, the study met criteria for inclusion in a Cochrane review, and as such it was a welcome addition to music therapy trials.

Regardless of the research method used to generate evidence that music therapy is helpful, evidence-based clinical decisions depend upon correct statistical interpretation of research results, whether they come from primary or secondary research. Hence the problem is not merely to provide evidence of effective practice but also to ensure correct interpretation of that information by others. Clearly it is vital that music therapists find ways of disseminating information to health service managers in ways that are clear and easy to understand. It is also important that the information they deliver as evidence of good and effective treatment come in a form that enables a manager to easily incorporate it among other sources of information.

The following vignette from a supervision session with a music therapist under pressure to supply data illustrates the consequences when a music therapy service is unable to provide suitable evidence. A music therapist who worked in a diagnostic assessment centre for adults with learning disabilities, where there were no restrictions on the length of waiting lists, reported that he could not meet the delivery requirements because there were too many referrals for music therapy. At the same time an attempt to increase provision of music therapy fell on stony ground. In one instance, even though a waiting list had 74 patients on it, the service was cut back because there was insufficient statistical evidence to show that treatment with music therapy was effective; the music therapist was too busy delivering therapy to deal with the demand for evidence. In another supervision session, a different music therapist remarked about her work in a centre for adults with mental health problems,

> "Questions are beginning to be asked about how relevant this is in relation to the statistics that need to be returned concerning evidence-based treatments."
>
> (Confidential communication from supervisee, 2005)

From this it is clear that, as Edwards (2005) has pointed out; different types of evidence are needed. Evidence to support posts is one requirement; but on the other hand, music therapists need to know that what they are doing is effective. In addition, music therapists want to be able to evaluate events that have special significance to them or their patients, even though evaluating these events may mean taking subtle changes into account, changes that may be felt rather than played out in music and that therefore may be very difficult to quantify.

The evaluation system proposed in this thesis would allow the therapist access to different types of evidence—subjectively observed, subjectively quantified, objectively gathered and objectively quantified. Both approaches are important in monitoring the process of music therapy over time.

3.5. Creating Music Therapy Evidence Using Qualitative Approaches

Due to the complexities and subtleties inherent within music processing in the brain (Liégeois–Chauvel et al., 1998) and the resulting cross-modal effects of music on physiological and psychological functions, music therapists have so far found it very hard to evaluate active music therapy in ways that generate quantifiable evidence. Since the late 1980s, many music therapists have considered qualitative research methods to provide greater scope for understanding music therapy. Qualitative research is mainly concerned with knowing about *the experience of music therapy* rather than the measurable changes that music therapy may or may not deliver.

> The music therapy experience is a complex one. It involves subjective realities and relates to multilevel intrapersonal and interpersonal relationships between client(s), music, and music therapist(s) (Amir, 1992). Music therapy is an aesthetic process which contains qualities such as creativity, intuition,

> inspiration, intention and spiritual elements. These qualities are connected to the inner state of the living being…. (Amir,1993).

As Amir points out, qualitative research methods allow music therapists to illuminate their subject in detail, and since her paper was published, many researchers have taken the qualitative route (Aigen 2008). Detailed and complex accounts of music therapy have extended music therapists' understanding of the subtlety and, so called, 'power' of music therapy, helping them to define their individual practices. But to take a devils advocate position for a moment; perhaps this approach is leading music therapists into something of a navel-gazing, Alice-in-Wonderland world, where aesthetic beauty, inspiration and spirituality bedazzle. Of 83 qualitative research studies published between 1987 and 2006 only one examined music therapy assessment, while a mere 11 reported on music therapy evaluation.

> Qualitative music therapy researchers demonstrate an overwhelming interest in discipline related topics compared to professional topics with 90% of studies undertaken in the former area. (Aigen, 2008, p. 253)

However, to argue in favour of qualitative methods, it can be said that attempting to evaluate distinct effects of music goes against the grain of music itself, for music integrates the whole person rather than limiting its effect to discrete functions (Streeter, 2006). For example, if a patient with cerebral palsy is treated with music therapy to help the patient gain control of movement, the emotions the patient feels in relation to their problems and in relation to the therapist are just as likely to be affected by the music as the behaviour of a particular muscle group. Emotion and movement, experienced in relation to music, are inextricably linked. Similarly, a child on the autistic spectrum, playing music with a therapist, may alter their body language, their vocal sounds and their level of concentration in relation to the music the therapist plays with them and therefore in relation to the inter-personal music therapy relationship. Indeed, music therapists have often prided themselves on being able to offer interventions that are not confined to isolated physiological or psychological aspects of an individual. In some music therapy circles this has been put forward as a reason to focus primarily on case study research (Aldridge, 2005) and to argue that we

should focus primarily on qualitative methods because they are better at addressing therapeutic relationships (Frommer & Rennie, 2001).

So music therapy is not conducive to isolating a problem and treating that isolated problem, and for this reason it is not easily adapted to the challenge of supplying evidence. Music has multiple effects; thus many music therapists have preferred to use qualitative approaches to investigate aspects of their own individual, and therefore unrepeatable, music therapy practice, often in the context of their individual work place. Qualitative investigation does not involve large groups of research subjects and does not make use of control groups. The quality of the experience, whether from the perspective of the therapist or that of the patient, rather than the quantifiable effects of the experience, is often the key factor in qualitative research. For example, in her study 'Bringing music to life: a study of music therapy and palliative care experiences in a cancer hospital' (O'Callaghan, 2001), O'Callaghan collated and then coded answers to open-ended questions that concerned the experience of music therapy, from the points of view of patients, visitors, and herself, as music therapist. Clearly in such a study a wide variety of factors must be taken into account. However, the study was rightly concerned with the quality of experience involved in receiving and delivering music therapy as a treatment, rather than the effect of music therapy treatment on particular physiological or emotional conditions.

It is clear from these examples that some music therapists prefer to undertake research using qualitative methods; indeed, some of the most interesting research in recent years has sprung from the use of such methods, which allow deeper investigation of music therapy as experience. However, because these research approaches are not designed to monitor session work systematically on a day-to-day basis in clinical settings, they have little to offer a therapist who is asked by a manager to deliver statistical evidence by next week. To date, qualitative research has taken a wide arc away from the systematic analysis associated with evidence-based practise. This is not to say that researchers using these methods are disinterested in the problem, but rather that over the last twenty years, while evidence-based practice has taken hold in medical fields, music therapists have been increasingly concerned with describing music therapy in ways that make sense to them.

3.6. Creating Music Therapy Evidence Using Meta-Analysis

In an attempt to acquire more credence through both qualitative and quantitative studies, music therapists have started to publish meta-analyses on a range of music therapy applications. Examples include: dementia (Vink, 2003), depression (Maratos, 2008), and brain injury (Bradt et al., 2009). The studies have found that some types of music therapy may be helpful.

However, a study by Gold, Voracek & Wigram (2004), on the efficacy of music therapy for children and adolescents with psychopathology, illustrates the difficulties researchers face when trying to argue that music therapy is actually effective. The researchers reviewed studies and conference presentations from a wide variety of sources, a total of 11 studies involving 188 participants. The studies included one randomised controlled study, 5 non-randomised controlled studies, and 5 studies with no control group. The authors concluded that

> The clinical implication of this meta-analysis is that music therapy is an effective intervention for children and adolescents with psychopathology. Music therapy produces a clinically relevant effect of a considerable size and is therefore recommended for clinical use. (Gold,Voracek & Wigram, 2004, p.1060).

However the National Institute for Health Research were critical of these conclusions. Their reviewers commented:

> This conclusion may not be reliable as it is based on an analysis combining primary studies of varying design and uncertain reliability.
>
> (National Institute for Health Research, 2008, online retrieval.)

Therefore, this meta-analysis can merely suggest that music therapy *may* help children with psychopathologies to improve their communication skills.

Similarly, another meta-analysis reviewed fifteen studies of music therapy with patients with multiple sclerosis, (Ostermann and Schmid, 2006). The authors concluded that music therapy was effective in promoting a positive self image and alleviating emotional distress in patients with multiple sclerosis. Yet the National Institute for Health Research's Centre for Reviews and Dissemination came to a different conclusion:

> Due to incomplete reporting of review methods, lack of assessment of validity and reliance on observational data, the authors' conclusions may not be reliable. (National Institute for Health Research, 2008)

Trying to squeeze a multiplicity of music therapy 'results' from such a wide variety of studies into a recognised scientific frame of reference can be a frustratingly difficult task. These music therapists were faced with the often idiosyncratic ways in which individual music therapists had observed and written about their work, together with a diversity of information and lack of systematic methods for evaluating treatment.

Notwithstanding the difficulties, it should be noted that the most recent Cochrane Review: Music Therapy in Adults with Acquired Brain Injury (Bradt et al., 2010) restricted the studies to be reviewed to those which employed a randomised control or quasi randomised controlled research design. However, similarly to former studies, the authors were only able to conclude that although rhythmic auditory stimulation (RAS) may be beneficial for gait improvement in people with stroke

> ..more RCTs (randomised control trials) are needed before recommendations can be made for clinical practice. More research is needed to examine the effects of music therapy on other outcomes in people with ABI (acquired brain injury). (Bradt et al.,2010 Abstract)

In conclusion, meta-analyses to date have shown that music therapy may be helpful. By proving that music therapy may be helpful, the need for further research is made credible, and in this respect the results of these meta-analyses are important for the future development of the profession. It is hoped that by developing a specialist

evaluation system that can systematically collect, sort and analyse similar types of music therapy data, researching music therapy will become easier.

3.7. Music Therapy Centred Theory and Evidence: The Field of Play (Kenny, 1989)

If a computer aided evaluation system is to meet the needs of expert music therapy practitioners who may understand their work from a different stand point to medical models of treatment, it is important to acknowledge attitudes to practice that bypass medical models.

It is not the purpose of this study to discuss or debate music therapy centred theories in depth. However, it is important to acknowledge that some music therapists draw on music therapy centred thinking to cope with a working world where the core mystery of music therapy, creative transformation, has little relevance to the managerial mind. A number of music therapists have proposed ways in which music therapy can be understood outside of a positivist framework, (for example, Kenny, (1989), Amir (1993), Austin and Forinash, (2005)). Here I describe Kenny's move towards her music therapy centred theory—the 'Field of Play.'

In a recent book, 'Feminist Perspectives in Music Therapy,' (Hadley, 2006), Dr Carolyn Bereznak Kenny contributed a chapter in which she described a number of 'epiphanies' that moved her away from clinically proven medical theories towards her music therapy centred theory, The Field of Play (Kenny, 1989). While working at the Danish Convalescent Hospital in Atascadero, California, Kenny encountered 'Debbie,' a 32-year-old woman injured in a debilitating car crash:

> She was sent to our hospital because she did not respond to the standard rehabilitation treatments. For many weeks we sat at the piano together. I improvised and she remained hunched over in her wheel chair. Then one day she reached up to the keyboard and began to play. After one year of working with Debbie intensively at the keyboard, and after she had started to speak again, another epiphany arrived. On this day, my hands could not write the standard medical terms in her chart because these words did not accurately

> describe my experience with her. This was the day I realised that I would have to create a new language to describe my music therapy practice.
> (Kenny, 2006, p.90)

Kenny writes of her 'slow and steady disillusionment with the language of psychology, medicine, and in general, the clinical world' (Kenny, 2006, p.90), which had been growing over several years of work at the Riverview Hospital, New Orleans, and a day treatment centre administered by the University of British Columbia Health Sciences Centre. Both facilities were guided by psychoanalytic approaches to treatment. Of these and other practices, she writes;

> Eventually I developed a healthy respect for psychological theories and other theories related to treatment and care, but I felt they were limited in their scope. I began to consider them as interpretative art forms, each fascinating in their own way. They were expressions of world views. But none of them represented a more holistic and elaborate approach to care than any of the others. The epiphany arrived when I came to understand that all of these theories were based on an image of a person that was an "ideal type."
> (Kenny, 2006, p.90)

Of her later PhD research, Kenny describes how after lengthy investigations of related fields, she realised that

> …it was time for music therapy to stand on its own two feet, in relation to other fields, by building its own concepts and principles from within its own discipline. (Kenny, 2006, p.91)

Her theory, 'Field of Play,' relates to three earlier concepts first identified by Sears (1996) as underlying the processes of music therapy:

- Experience within structure
- Experience in self organisation
- Experience in relating to others

In an earlier text, ‘The Field of Play’ (Kenny, 1989) Kenny interpreted Sears’s theory as follows:

> On the theoretical level, Sears provides an environmental approach—one which offers fields, conditions, relationships and self-organisation. Explicit within his three classifications are self organisation and relationships (relating). Implicit are fields and conditions. (Kenny, 1989, p.27-28)

Kenny invited music therapists to imagine their patients and clients as bio-regions. She later argued that this was not a ‘fanciful suggestion’ (Kenny, 2006, p.88); rather, she claimed, it is rooted in ethical imperatives derived from an examination of her own native American standards of conduct and what is known as the deep ecology movement (Drengson & Inour, 1995).

So where does this leave an everyday, working music therapist in an NHS hospital? In this writer’s view, the majority of music therapists simply wouldn’t know where to start in attempting to use this theoretical position to justify a treatment method; yet they may well feel drawn to this different sort of ‘knowing,’ recognising from their own practice that people they have helped have often engaged in subtle and deep connections not only with music but with the music therapist.

However, even though therapists might reflect on their practices using emotional vocabulary and visually descriptive text, conceived in relation to their musical and emotional experiences with clients, this does not necessarily preclude the use of a computer system to analyse such texts, either spoken or written, in relation to the music stored. This thesis proposes that music therapists be enabled to make use of text-linked music retrieval both to subjectively evaluate their work and to present evidence of these evaluations in quantitative form if desired.

3.8: Creating Evidence Using Musical Analysis

Music therapists using expressive musical techniques have always directed particular attention to gathering information about changes occurring within the patient’s, and

the patient's and therapist's, improvised music, (Nordoff and Robbins 1971, Streeter, 1979, 1981, 1999, Bruscia 1987, Frederiksen 1999, Lee 2000, 2003, Pavlicevic, 1991, 1997, 2000, Robarts, 2000, 2001). Many of the descriptions of music analysis contained within these publications were drawn from material contained within audio recordings of music therapy sessions delivered by the authors.

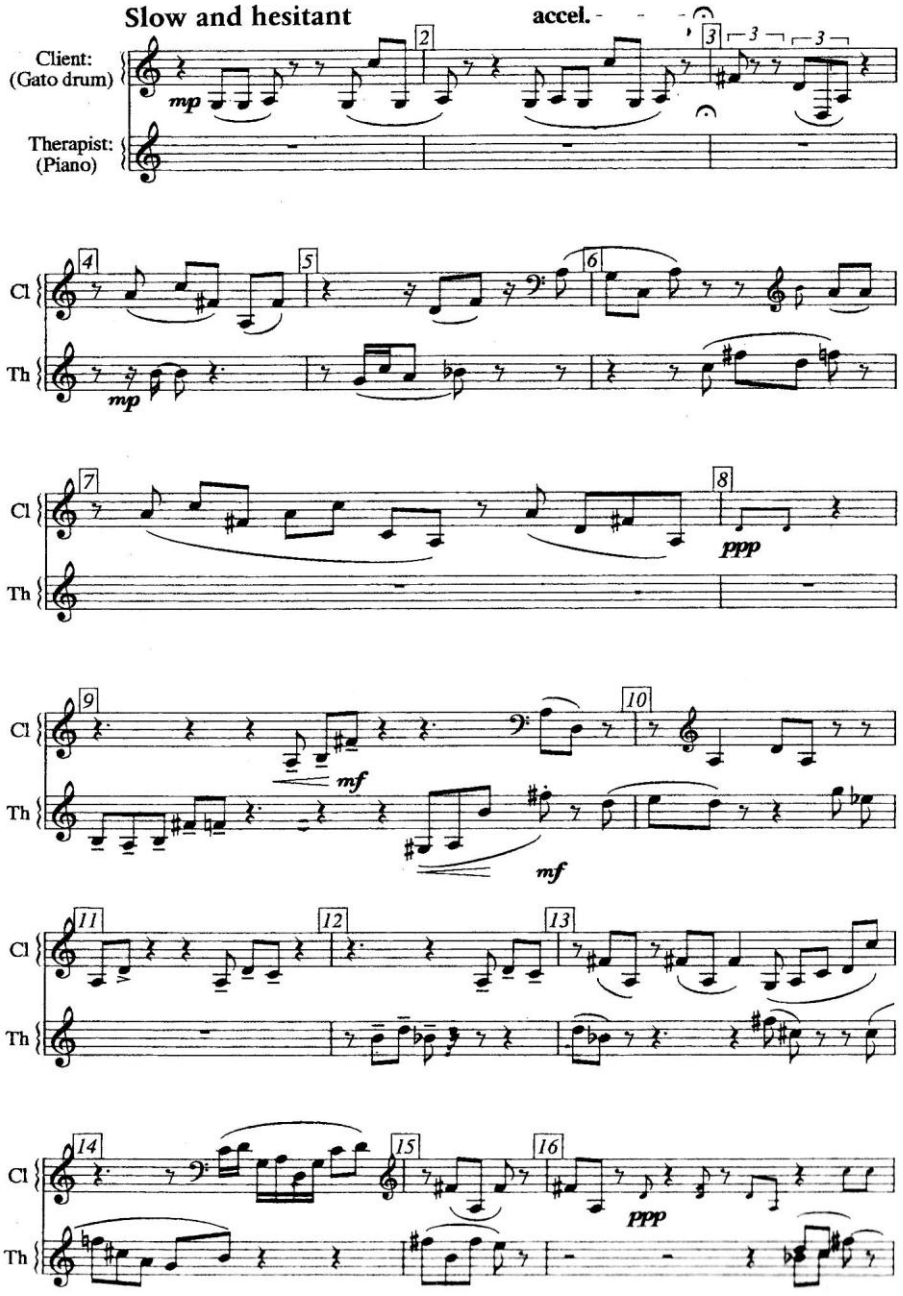
A brief overview of the different approaches to music analysis shows that, although there are overlaps, the key differences fit broadly into three areas. Some therapists propose pure music analysis as the core method for understanding what takes place in music therapy; see, for example, Lee's Architecture of Aesthetic Music Therapy (2003). Others have been concerned with reflecting on musical analysis in the context of developmental theories, such as those originated by Stern (1977); for example, Streeter, 1979, 1981, Pavlicevic, 1991 and Malloch, 1999.

Some writers, for example Streeter, 1999 and Metzner, 2000, have argued it is possible to track changes in music that reflect psychoanalytic processes felt at an emotional level and played out in music.

Figures 3:1 and *3:2* show notated extracts used by the author to help her evaluate her use of music with a self-referred adult. In this therapy the client used speaking as well as improvised music play, and the therapist was trained in a psychoanalytic approach. It was therefore possible for the author to investigate whether emotional events that occurred for her within the transference relationship could be identified as reflections in the musical exchanges which occurred between herself and her client in their improvisations.

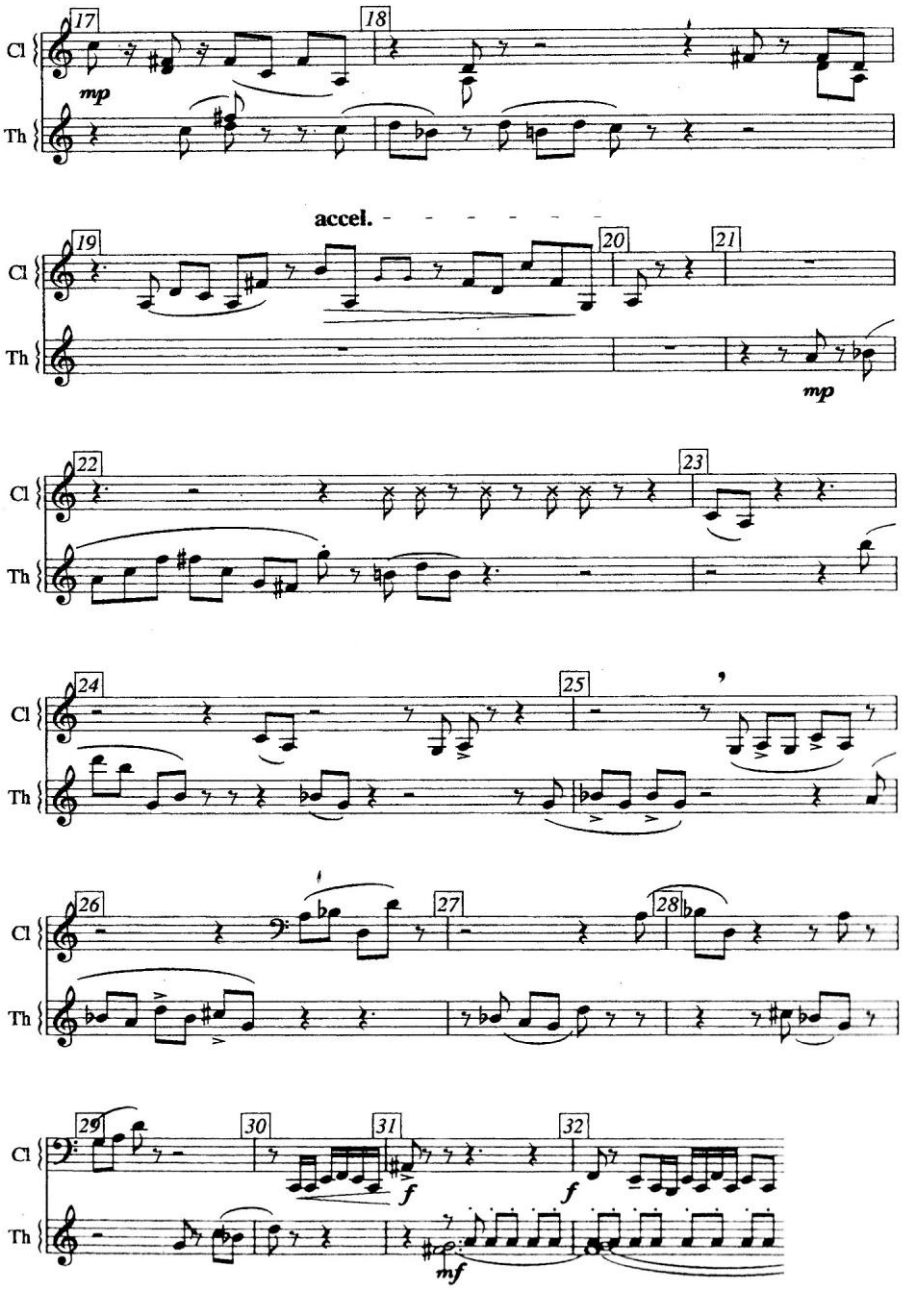
Figure 3:1 shows an extract from an early music therapy session in which the client was unable to formulate plans for her future and similarly was unable to sustain her musical ideas in shared improvisations with the therapist, leaving the therapist to move them forward, (for example, at bars 9, 21, 23 and 31):

Figure 3.1: A notated extract from an early improvisation



(Streeter 1999: p.90)

Figure 3.1: (Continued) A notated extract from an early improvisation

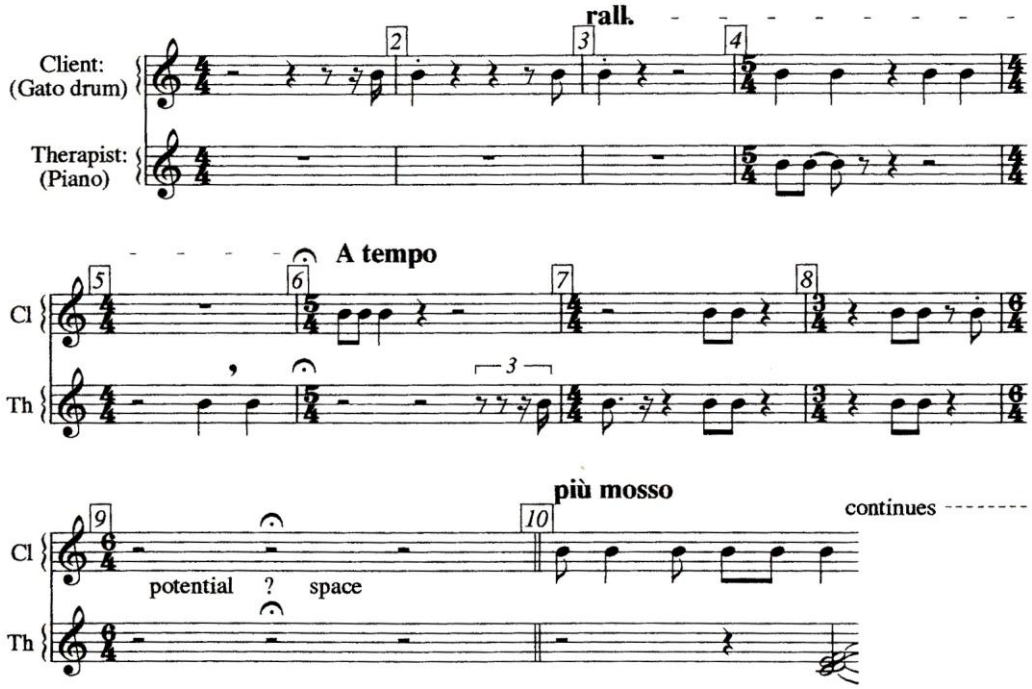


(Streeter 1999: p.91)

Although the therapist tried to avoid taking direction of the musical ideas, she found it hard in the first few sessions to avoid solving the problem of what to play next. The extract was then compared to an extract taken from the start of a later session (*Figure 3:2*) in which the client was beginning to imagine ways in which she could

move her life forward, whilst the therapist (the author) was better able to stay with her client's small, self directed steps forward in their shared music.

Figure 3:2: A notated extract from a later session



(Streeter, 1999, p. 99)

Here the therapist's input has become so finely tuned to that of the client that the two find themselves playing in unison in bars 7 and 8, leaving the client with a predicament; whether to slip back into her familiar following role or to move the music forward herself. The author understood the silence in bar 9 as a potential space (Winnicott, 1971) in which the client was faced with a choice: wait for the therapist to lead the way or take on that role for herself. By the end of the extract the therapist was well established in an accompanying (supportive) role while the client was beginning to develop her own material forward into the future of the music. The purpose of the analysis was to attempt to track whether similarities were occurring in both the verbal /emotional and the musical / expressive fields (Streeter, 1999).

Undertaking such minute analyses of small excerpts of music—a technique labelled later by various authors as music therapy micro-analysis (Wigram et al., 2007)—

engages music therapists in a rich, yet extremely time-consuming means of gathering subjectively observed evidence. As a method of evaluating practice on a week-by-week basis, it is impossible to use such a technique.

This thesis investigates whether music therapists can be assisted in their self-evaluations by using computational music analysis delivered by a system that can store, analyse and track changes in musical events, as directed by the music therapist. However, musical analysis is only one aspect of the proposed Music Therapy Logbook system. No specific bias towards one or other music therapy method is implied. Hopefully, music therapists will be offered a choice of ways in which they can use the system for gathering different types of evidence, both musical and non-musical. Some may use it to further substantiate the importance of complex musical processes to an understanding of music therapy; others may use it for quantitative measurements of, for example, the amount of time spent in shared playing with the therapist, or a decrease in the obsessional musical behaviour of a child on the Autistic Spectrum. The Music Therapy Logbook system is conceived as a tool to enable music therapists to deepen their practice evaluation, in whatever ways are appropriate to their style of work and the demands of their workplace.

3.9. Creating Evidence Using Data Analysis Programs

Literature on the use of technology for music therapy evaluation is limited. Crowe and Rio (2004) noted that as early as 1972 Parker and Graham advocated the development of an information retrieval system for music therapy, pointing out that

> Scholars in the arts and humanities have made relatively little use of the storage and retrieval capacities of the computer and musicians have practically ignored the entire area until very recently. (Parker & Graham, 1972, p.147)

In the same paper the authors proposed using an IBM 360 system, suggesting that what they meant by the term ‘retrieval system’ was not a *music* retrieval system but a means by which written information could be stored and retrieved. Crowe and Rio

(2004) point out that the first evidence of such methods being used by music therapists comes two years later when Eagle and Prewitt (1974) created the Music Therapy Index.

There is some evidence that music therapists were using computer systems for data organisation by 1981. Hasselbring and Duffus (1981) used a microcomputer to analyse the behavioural interactions between a music therapist and a 55-year-old learning-disabled client. This study demonstrates that early attempts were made to use computer technology to collect and analyse data in both research and training activities. In addition, the AIMSTAR charting program, although not designed by a music therapist, was being cited in the music therapy literature (Hasselbring & Duffus, 1981), and it was later used in music therapy settings to train students to write goals and objectives and to graph client data using a data organisation system. By the late 1980s Krout noted that music therapists were increasingly using computers and computer software in their clinical, educational and research settings (Krout, 1987).

By 1994 Bunt noted that computer technology and software was being used to support music therapy research (Bunt, 1994), and by 1997 measurement equipment such as the Continuous Response Digital Interface was being used by music therapists to measure various responses to music in music therapy research (Crowe & Rio, 2004).

It is clear that by the year 2000 music therapists had begun to make use of the possibilities inherent in developing computerized databases. Gallagher (2001) conducted a pilot study in which a computerized database was used to evaluate clinical practice with 90 patients (aged 28-84) in an inpatient palliative medicine unit. The researchers used their database to track the effects of music therapy intervention on their patients' common symptoms. The results of this research indicated that music therapy appeared to have a significant effect on common symptoms in advanced cancer patients.

It is important to note that of the two internationally comprehensive editions of music therapy research (Wheeler, 1995, 2005) the second includes two chapters devoted to the use of computer programs while the first has none dealing with that subject. This would seem to indicate that data management and analysis systems have become increasingly useful to music therapy researchers in organising and analysing their data.

The use of the Statistical Package for the Social Sciences (SPSS), which is widely used in research in social science fields, has been particularly emphasised (Meadows, 2005). Writers have referred to the growing use of such data management systems for storing and organising information, particularly information related to research (De Cuir, 2005, Musumeci et al;. 2005). Such data analysis programs play an increasing role in social science research and health science research. For example, SPSS was used for the analysis of Surveys 2 and 3 described in this study.

Three software programs were described at that time as particularly useful to music therapist researchers. These are ATLAS.ti, HyperRESEARCH2.5 and Nvivo2.0 (Musumeci et al., 2005). ATLAS.ti was found to be particularly effective for music therapy qualitative data analysis. ATLAS.ti allows a researcher to scan images of musical scores, make coded interventions onto the score itself, listen to audio tapes from within the program and code sections of the music using text or graphics. Musumeci states that the use of ATLAS.ti was particularly important to the flow of thinking because it enabled the music therapist '...to remain as close as possible to the music - the primary data source' (Musumeci et al., 2005, p. 189). It is useful to note the emphasis being placed here on the proximity of the researcher to the data source—music.

It is clear from the proliferation of research on music therapy that the ability of computers to manage information is being put to good use, at least by music therapy researchers, even though at the moment the applications music therapists use are largely limited to information retrieval systems and statistical measurement analyses.

There is some evidence to suggest that music therapists have also used computer programs to systematically write session notes. Crowe and Rio (2004) noted that charting programs such as EMTEK were being used to create written session notes by some American music therapists.

The increasing use of computers by music therapists suggests that the time is ripe for the creation of software packages that combine data storage, data management and data analysis of musical and non-musical information in a single, bespoke tool.

From the literature reviewed above it is evident that music therapists have been attentive to developments in technology for many years now. The Individual Music Therapy Assessment Profile—IMTAP (Baxter et al., 2007) is a recent software package that helps to manage data arising from music therapy assessments. Devised by six American music therapists to assess the skills of children and adults with special needs, the user is offered standardised assessment forms in PDF format on a CDRom, onto which data can be directly entered. This allows a music therapist to record subjectively observed data on musical and other behaviours in a standardised format and thus to notice trends emerging over time. The program does not, however, have the capacity to analyse music recordings. IMTAP is a welcome move forward and has been reviewed very positively by the music therapy community (Baker, 2009), particularly for the sophisticated scoring system, which takes a number of different musical skills into account.

3.10: Creating Evidence Using Computational Music Analysis

There has been a small but steady increase in music therapists' use of computer technology for the computational analysis of music, and over the last ten years music therapists have been showing growing interest in investigating the potential of computational music analysis for music therapy evaluation (Streeter, 2007). In particular, therapists have begun to use recorded music to systematically analyse (Verity, 2003; Erkkila, 2007; Streeter, 2008) or systematically describe (Gilboa 2008) music therapy sessions.

Analysis of music using computers was first undertaken by Professor Colin Lee in the late 80s and early 90s. Lee used computer notation software to help evaluate music therapy with HIV/AIDS patients (Lee, 2000).

The first prototype system devised to analyse music therapy musical information, the Computer Aided Music Therapy Analysis System (CAMTAS), was developed during the mid-90s by Adrian Verity and Ross Kirk of the Music Technology Group, University of York, in collaboration with Mary Abbotson, music therapist and former director of the North Yorkshire Music Therapy Service (Hunt, et, al., 2000).

CAMTAS was designed to deliver quantifiable measures of therapeutic effectiveness. For example, CAMTAS provided quantitative time-based profiles of the progress of a client's condition by tracking the client's physical activity over a section of musical improvisation and comparing this with previous sessions. This prototype system processed synchronised data from music therapy video and audio recordings, when a MIDI (Musical Instrument Digital Interface) keyboard and acoustic instruments with sensors wired to a central computer were used during the music therapy sessions. Rhythmic analyses were successfully used to test the system, replicating Thackray's calibrated tests of rhythmic ability linked to age. However, CAMTAS was limited at that time, partly because contemporaneous computing systems were unable to cope with the multiple real-time audio streams required by music therapists, but also because the system used wires and leads in the music therapy room—requiring therapists to alter the way in which they would normally work. In addition CAMTAS could not record acoustic instruments, only instruments that were electronically linked or MIDI based.

Over the last decade, interest in evaluation tools to assist music therapists has increased. Erkkilla et al. (2007) have been developing a Music Therapy Toolbox, which uses open-source software to analyse MIDI recordings. Benvenista (2009) is developing the MAWii music therapy system, which uses Wiimotes as virtual instruments in group music therapy sessions with children, allowing data to be downloaded onto a computer for later analysis by open sourced software. Gilboa and Klein have investigated a notation system, The Map (2007), which allows therapists to choose from a directory of event types and subjectively annotate music therapy events. The MAP interfaces with presentation software and is intended to be a qualitative annotation tool rather than a quantitative analysis system. At this point in time the Music Therapy Logbook prototype, described later in this thesis, is the only system to have been tested by a music therapist for use in evaluating music therapy sessions in which acoustic, as well as MIDI, instruments were played (Streeter et al., 2008).

In this thesis it is not necessary to report on all of these systems in detail. Streeter, Gilboa and Erkilla (2008) contributed to a round table on computational music therapy analysis at the World Congress of Music Therapy held in Buenos Aires,

Argentina. During the round table presentation, all three systems were summarised. The music therapists who attended the round table were excited by the possibilities for using such tools and overwhelmingly in favour of continued work with these innovations.

3.11. Literature Review: Conclusion

It is clear from this overview of the literature on music therapy evaluation that different styles of practice have spawned different approaches to evaluation and assessment. The fact that each country has a relatively small number of music therapists contributes to the diversity of approaches; but equally important is the diversity of conditions with which music therapists work. Music therapists are not entirely in agreement as to how best to systematise evaluation methods, if indeed they can be systematised, although there is growing awareness of the need for this.

Three factors affect their views: i) the clinical population with which a music therapist is most experienced, ii) the ethos of the clinical setting in which they work and iii) the style of practice in which the therapist was originally trained. Therapists' opinions differ as to whether musical data should be central to evaluating music therapy; there is concern as to whether qualitative descriptions and single case studies can stand scrutiny by other health professionals. There are some who propose that standardised methods of evaluation and assessment are vitally important. There are others who feel that conceptualising (and therefore attempting to evaluate) therapy as a linear, or hierarchical, process is incompatible with its unfolding, uncertain nature. But music therapists do agree on one point: they are under increasing pressure to evaluate their practice. It would therefore seem sensible that the more methods they hold in common, the better.

On the basis of this literature review, it would seem fair to state that current approaches to the evaluation of active music therapies (in which patients create music with their therapists) appear to rely mainly on subjective observation described in words, although there has been considerable research on the use of statistical analysis programs for research purposes and more recently for patient assessment reports.

The reports music therapists write need to match the requirements of the units in which they work. Drawing on my experiences as a clinical supervisor, it seems that most therapists settle into a reluctant compromise, accepting the impossibility of monitoring their musical interventions and the results of those interventions on a regular basis. This tends to be undertaken only for a special presentation at a conference or when something unusually interesting is happening. Presentations to colleagues and staff therefore often centre on the peak moments of exceptional events, with these then compared with the low points of music therapy. There is often no time to track less interesting clinical material in comparison with such high and low points, and this can give rise to misleading impressions of the process of music therapy as it evolves over time.

The need, and desire, to clearly communicate the effectiveness of music therapy when services are developed according to their relative success in providing evidence, is now shared by many music therapists. Wigram's forewarning that 'Music Therapy cannot escape scrutiny so we might as well be prepared, or funding to pay for services will be eroded and ultimately withdrawn for lack of evidence' (Wigram, 2002. p23) is fast approaching.

Quite understandably music therapists may be reluctant to spend time on evaluation when they do not have access to a proven tool. Given access to a specialist evaluation tool, it is possible to surmise that more music therapists might undertake systematic evaluations. Technological advances in computing mean that, for the first time in the development of the music therapy profession, we are beginning to embrace both ends of the spectrum; the requirements of the health contexts in which we work, together with, rather than in conflict with, analysis of music that has subtle effects upon physiological and psychological well being.

Music therapists need to feel safe in the knowledge that whatever a statistician may think about their work, they themselves have the inner resources to draw on creative inspiration in their work with their clients. Without this, a music therapist cannot function. There is sometimes a conflict; music therapists on the one hand, managers on the other, evidence floating somewhere in between, sometimes thought of as the last thing music therapists want to consider because they don't see it as a creative task.

The proposed Music Therapy Logbook, then, attempts to bridge theoretical differences—on the one hand the empirical world, on the other the intuitive—to find a hybrid or third way that enables music therapists to make use of both in their professional practice. By returning to the central core of our work—the music made—and bringing a powerful analytical tool to bear on this, we have the beginnings of a means by which music therapists can evaluate whether the music therapy techniques used are delivering what the therapist wants them to deliver.

Therapists will always need to resonate with and reflect upon their experiences with patients and the music they have shared together, and then to synthesise this knowledge with the work they do. However, it seems to me that this core process has, at the moment, very little to do with what is generally understood as producing 'evidence' and perhaps this is why many therapists are at a loss when asked to do that. Rather than putting forward another model for evaluation, the present research investigates a tool which, it is hoped, will be useful to music therapists with different backgrounds and training, working with different patient populations, whether or not they agree on how to conceptualise the data that they gather.

The music created between therapist and patient is true data—once recorded the music data contains time based events; a positive attribute of computers is that they have no opinions or attitudes. The Music Therapy Logbook system investigated in this thesis merely sets out to collect data and help therapists access it in ways that are statistically useful for whatever type of evaluation they wish to apply.

CHAPTER 4:
Gathering Music Therapists' Opinions on Using Computational Music Analysis for Evaluating Music Therapy

4.1. Introduction

A specialist computational analysis system (designed to assist music therapists in evaluating music therapy) must meet the needs of therapists if it is to be of use in the real world. Therefore the functions of the proposed Music Therapy Logbook system need to be relevant to UK therapists working within the guidelines laid down by their regulatory body, the Health Professions Council (HPC). In particular, the proposed system aims to help therapists better meet the following standards of practice:

- *recognise the need to monitor and evaluate the quality of practice*
- *be able to gather information, including qualitative and quantitative data, that helps to evaluate the responses of service users to their care*
- *be able to monitor and review the ongoing effectiveness of planned activity and modify it accordingly*
- *be able to demonstrate a level of skill in the use of information technology appropriate to their practice*

(Health Professions Council 2010)

From these it is clear that therapists in the UK are advised not only to keep records of their therapy sessions but to make use of those records to inform and improve their practice. However, as can be seen from the survey results presented and discussed in this chapter, health managers' requirements for written descriptive records very often take precedence over gathering and analysing data derived from recorded music, so that monitoring changes in musical expression and perception is rarely attempted as a means of explaining changes in health and well being.

The type of information health managers require therapists to produce can therefore limit the ways in which other professionals come to understand what music therapy can and cannot achieve. For a computer aided music therapy evaluation system to be relevant, the evaluation methods currently used by music therapists need to be taken into account. But above all, the opinions of music therapists need to be sought as to what types of computational analysis tasks are likely to be helpful to them in future. Therefore in this section, the user opinion investigation work is presented, analysed and discussed. A description of the methods employed introduces the section.

4.2. Survey Methods

The original intention was to survey a small number of expert music therapists to find out what they wanted a computer aided evaluation tool to do, if anything. Then, by analysing those results, this expert feedback was to be reduced down a number of times to arrive at a few key areas of investigation as to the proposed design of the system.

However, it was also necessary to take into account the advice of engineers; in doing so it became clear that computers are limited in terms of what they can actually deliver (as regards music analysis) at this time. It was decided to first scope technical limitations before asking music therapists what they want. Therefore, rather than starting from a position of 'anything is possible' the technical realities were presented to music therapists to find out what level of fit there is between what computers can do now, what they are likely to be able to do in future, how music therapists evaluate their work now and what they want a specialist evaluation system to deliver in future.

This does not mean that technological limitations drove the research, but that technological issues were taken into account when asking music therapists their opinions. There would have been little point in generating ideas for a system that could never be delivered. The point of the research has been to keep the realistic prospect of future product development in mind throughout. The Music Therapy Logbook system is being developed to meet the needs of therapists with varying levels of experience and on this basis it was eventually decided to seek a wider spread of opinion from music therapists with different amounts of experience.

Opinions were therefore sought from groups of music therapists in five stages: first, a brief survey of six UK therapists working near the University of York (Survey 1). Drawing on these responses, a pilot survey was constructed and sent to a UK group of nine experienced music therapists; the survey asked about their current evaluation methods, their attitudes towards using computational analysis in future, and also for general feedback and comments. This completed the pilot investigations prior to constructing Surveys 2, 3 and 4.

Concerning the technical requirements for the evaluation system to be tested, the author met with one music therapist, two engineers and a clinical physicist to consider the development of computational analysis functions associated with the system to be tested. The music therapist was employed by the National Health Service in a neuro-rehabilitation setting. The clinical physicist also worked in a neuro-rehabilitation setting. (Together with the author, these experts formed the core research team for the White Rose Health Technology proof of concept project for the proposed Music Therapy Logbook system, which the author led during 2008/2009.)

Survey 2 was sent to 10 music therapists who were all working in neuro-rehabilitation settings but had varying levels of experience. They were asked to report on their current methods of evaluation, asked to rate preliminary computer analysis tasks (which by that time were being tested in a laboratory setting without involving patients), and other functions not yet tested but likely to be possible in future. The Survey 2 respondents were also asked for general comments.

Based on these responses, additional questions were added to create Survey 3. This was sent to a larger group of international music therapists working in the field of neuro-disability. By the time Survey 3 was sent out some of the computational analysis tasks had already been established as possible in laboratory tests (without patients); the others were thought to be technically possible in future but required further development.

By limiting Surveys 2 and 3 to music therapists working in the same clinical field, therapists' preferences for computer analysis tasks were gathered in relation to a specific clinical context. Therefore, in future it will be possible to compare these

results with results from additional surveys with therapists working in different clinical fields. In this way it will be possible (in future) to build up a detailed picture of music therapists' opinions on computational analysis as related to the different clinical fields they work in, so that the final system (if and when it is produced) can properly meet the needs of music therapists working in a variety of different settings.

Based on the results of computer engineering tests and the comments and responses thus collected , a final survey of the whole membership of the UK Association of Professional Music Therapists (APMT) was undertaken; Survey 4. Survey 4 did not attempt to gather opinions based on specialist fields but to scope opinions on specific analysis functions and attitudes to future use. Therapists were asked to select preferences from a list of computer program functions and to select statements that matched their opinions as to whether or not they would use such a program to help them evaluate their work. The therapists were invited to list any additional functions they thought relevant and to leave general comments.

Therefore, the engineering research work and the user opinion research moved forward in tandem. It should be noted that the user opinions presented in this thesis do not set out to represent the opinions of all music therapists. Taking into account all of the opinion sourcing research as a whole, 198 music therapists were involved in giving feedback. Survey 1 collected 6 responses, nine therapists collaborated with the pilot survey, four therapists met with the author to discuss evaluation needs, Survey 2 collected 10 responses, Survey 3 collected 44 responses and Survey 4 collected 125.

4.3. Survey 1

In September 2006 the author presented the concept of Music Therapy Logbook to the north-east regional meeting of the Association of Professional Music Therapists. Six therapists attended the meeting which was held on a weekend. All of the therapists had more than one part time job and most were employed on an hourly basis. Only one therapist was employed by the National Health Service (in an adult mental health service); the others were working in special schools, social service settings and private care homes delivering long term care to individuals with special learning needs.

The therapists were asked to fill out a quick questionnaire, then to discuss any issues that it raised. They were asked to report on the types of information their employers required them to collect, then how able they were to collect those different types of information. *Figure 4:1* shows that descriptive information, written down in reports and notes formed the predominant employer requirement. There was a very low requirement for evidence of the specific benefits of music therapy to a patient (or client) and no employer required a music therapist to make audio recordings of their musical work, although one required video recordings. However, the majority of therapists were required to report on patient progress.

Figure 4:1: Survey 1: Types of Information Employers Require

Q.1: Listed below are some of the types of evidence some employers may ask music therapists to collect. Please tick any statements that apply to you in your work as a music therapist, whether or not you are able to deliver the type of information stated.

(Rows in bold show the most frequently reported employer requirements)

Types of information employers require	***Number of music therapists reporting requirement***
No information required	0
Number of music therapy sessions delivered annually	2
Number of patients seen in a month	3
Number of patients seen in a year	0
Number of children seen per term	3
Number of patients on music therapy waiting list	2
Regular written reports on patient progress	**5**
Written records of all music therapy sessions delivered	**6**
Written records of all music therapy assessments undertaken	**6**
Engagement in research into music therapy practice	3
Measurements of changes in behaviour as a result of music therapy	1
Audio evidence (recordings) of music therapy sessions	0
Video evidence (recordings) of music therapy sessions	1
Statistical evidence of the benefits of music therapy to clients	1
Provide research evidence that proves that music therapy works	1

The results show that most of the music therapists surveyed were not required to deliver information derived from an analysis of recorded musical data.

In contrast, the results illustrated in *Figure 4.2* show that most of these same therapists were able to make recordings of their music therapy sessions.

Figure 4.2: *Survey 1: Types of Information Music Therapists Can Deliver*

Q.2: Listed below are some of the types of information employers may ask you to collect. Please tick only the types of information you are able to deliver now.

(Rows in bold show the information most able to be delivered)

Types of information therapists able to deliver	***Scores***
Number of music therapy sessions delivered annually	4
Number of patients seen in a month	**6**
Number of patients seen in a year	**6**
Number of children seen per term	4
Number of patients on music therapy waiting list	**5**
Regular written reports on patient progress	**6**
Written records of all music therapy sessions delivered	**6**
Written records of all music therapy assessments undertaken	**6**
Engagement in research into music therapy practice	0
Measurements of changes in behaviour as a result of music therapy	0
Audio evidence (recordings) of music therapy sessions	**5**
Video evidence (recordings) of music therapy sessions	3
Statistical evidence of the benefits of music therapy to my clients	0
Provide research evidence that proves that music therapy works	1

These results suggest that although the majority were able to record their musical work with patients, it would seem they were not using those recordings to measure changes in their patient's progress. (This is the gap that the proposed evaluation system aims to narrow.) No therapist could deliver statistical evidence of the benefits of music therapy and only one therapist was being asked to deliver such statistical evidence.

Five of the six therapists had more than an hour a day to undertake evaluation; the sixth reported that she had one hour per working day.

Following the questionnaire, the group discussed the issues it had raised. The majority reported that they did not set aside time for evaluation on a regular basis so it was difficult to work out how much time they actually had available. They tended to fit evaluation in around other tasks when a deadline came up or when they found they had time to fill. The group informally reported that even though the majority did have enough time at work, evaluation often took place at home, after work. Most of the therapists were not attempting to systematically evaluate the degree to which music therapy was benefiting their patients. This question was rarely raised because the

therapists reported that, unlike other professionals (for example, speech therapists), they do not have access to validated outcome measures. It is important to note that all of these therapists were working for more than one employer and the majority were employed on an hourly sessional basis. Delivering the music therapy sessions was their priority when they were at work.

4.4. Survey 2

Aims

Survey 2 sought opinions from ten music therapists who meet quarterly to discuss issues of special interest concerning their work in UK neuro-rehabilitation settings. The survey aimed to scope the type of patients they were working with, the methods they were using to monitor their work, and to establish their general level of interest in using a computer aided evaluation system in future by giving brief descriptions of the ways in which it could be used . The survey also gave space for comments.
(To view Survey 2 please refer to Appendix 1, page 218.)

Respondents (N=10)

The number of years since qualification ranged from one to twenty two years; eighty percent of the therapists had been trained for three years or more; the mean number of years since completing training was 6.4 years. There were two very experienced therapists, (15 years and 22 years since qualification). Two therapists had trained at the Nordoff-Robbins Music Therapy Centre, two at the Guildhall School of Music, three at the Roehampton Institute, one at Anglia Ruskin University, and two had trained in Australia. Their styles of practice therefore reflected a spread of different approaches. One male therapist returned Survey 2. Some were employed full time, others part time.

(Although the number of respondents is small, an analysis of the data is discussed below so that these results can be compared with results from the larger surveys, 3 and 4.)

Survey 2: Results

Ninety percent of the therapists reported that they were more likely than not to make use of such a system in future. The overall mean rating was 77% likely to use it in future. The newly qualified therapists together with the most experienced therapists showed the highest level of interest. There was a slight increase in rating if the therapist was working part-time rather than full time. *Figure 4.3* shows the correlations:

Figure 4.3: Survey 2 - Likelihood of Using Analysis Tool in Future / Time Since Training / Part-Time or Full-Time Employed

Years Qualified	Likelihood of using Tool	Part time/Full time
1.00	85%	Part time
2.00	88%	Part time
3.00	**78%**	Full time
3.00	**77%**	Full time
3.00	**75%**	Part time
3.00	**65%**	Full time
5.00	**80%**	Full time
7.00	**50%**	Full time
15.00	83%	Full time
22.00	94%	Full time

(Mid-years therapists are shown in bold)

As a sub-group the mid-years therapists seemed less enthusiastic about the use of such a tool than either the very recently qualified therapists or the very experienced therapists. Perhaps the enthusiasm of those newly qualified and those who have maintained their practice over many years may have influenced these responses?

Therapists were asked to report on what conditions they treat with music therapy. *(Figure 4.4* indicates the conditions.) Most therapists were treating either patients with a traumatic head injury (over half of whom had received a severe head injury) or patients who were known to have learning disabilities. Many of these patients would have been unable to give feedback as to how helpful they found their music therapy

sessions; only one therapist was monitoring work by using a patient questionnaire to ascertain whether the patient thought the music therapy useful.

Figure 4.4: Survey 2: Conditions Treated by Music Therapists

Conditions and Disorders treated by Music Therapists	***Percentage of Therapists Treating Each Condition***
Severe Acquired Head Injury	80
Mild Acquired Head Injury	60
Learning Disability	60
Multiple Sclerosis	40
Brain Stem Infarct	30
Parkinson's Disease	30
Multiple Systems Atrophy	20
Motor Neurone Disease	20
Huntingdon's Disease	10
Stroke	10
Low Awareness States	10
Epilepsy	10
Batten's Disease	10
Acquired Hypoxia	10
Cerebral Palsy	10

Figure 4.5 indicates the variety of methods used by the therapists for monitoring music therapy sessions. In line with the results from Survey 2, the predominant methods involved writing notes and reports. Similarly, although most therapists were recording their work using audio or video equipment, fewer were reviewing recordings to help them write up notes.

Some therapists reported using musical notation to describe events, some reported counting musical events. However, therapists were less likely to incorporate quantifications of musical events in notes and reports. This again points to the gap

between the ease of recording musical information and the difficulty of using such data to inform evaluation.

Figure 4.5: Survey 2: Methods Used by Therapists to Monitor Practice

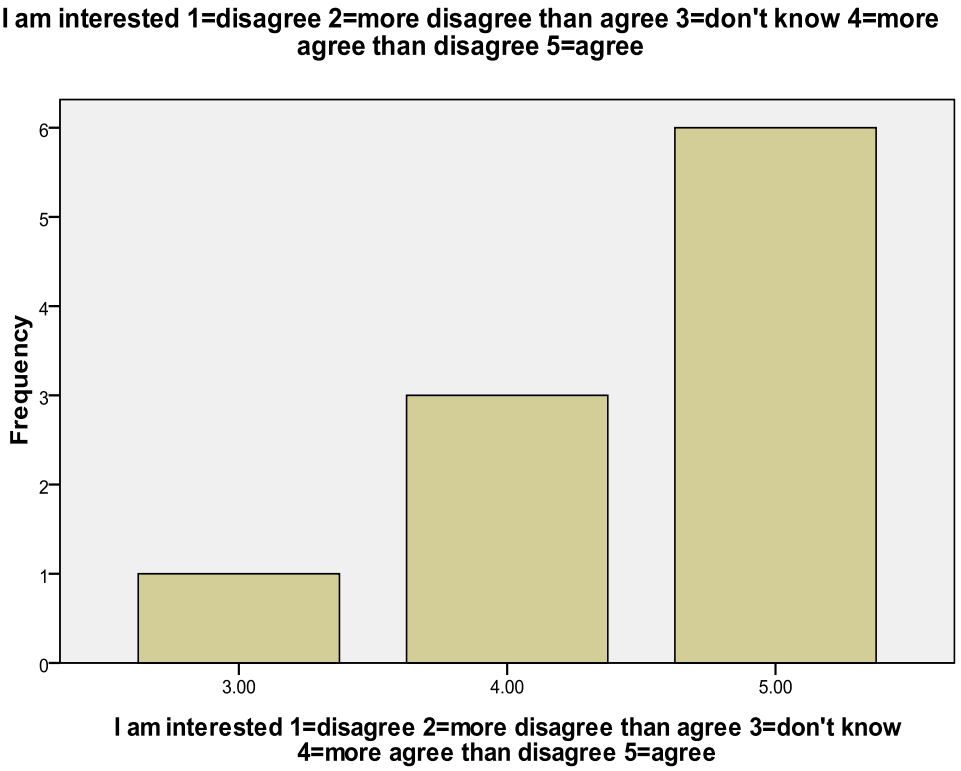
Methods Used by Music Therapists to Keep Track Of Their Work with Patients	***Percentage of Therapists Using Each Method***
Writing brief notes shortly after session	100%
Writing ward notes	100%
Writing case conference reports	100%
Writing assessment reports	90%
Recording the session with video equipment	80%
Watching video recordings and writing notes	80%
Recording the session with audio equipment	80%
Listening back to audio recordings and writing notes	60%
Use of musical notation to describe events	60%
Counting musical events in audio or video recordings	50%
Playing an instrument or singing	50%
Listening back to audio or video then writing down musical notation	40%
Categorising information contained in audio recordings	40%
Systematic method of writing notes	40%

Four (out of 10) therapists reported using systematic note writing; two of these were using the same approaches; the prototype Music Therapy Assessment Tool for Low Awareness States (MATLAS), the Visual Analogue Mood Scale (VAMS), the Visual

Analogue Self Esteem Scale (VASES), and the Sensory Modality Assessment and Rehabilitation Technique (SMART).) However, the results shown in *Figure 4.5* suggest it may have been difficult for the majority of these therapists to systematically monitor how their patients' use of the music therapy sessions changed over time.

Using a five-point rating scale, with 5 representing the highest level of agreement, the therapists were asked to rate 9 statements on their attitudes towards '*letting a computer program help you gather, organise and display data from recordings of music therapy sessions*.' *Figures 4.6a, 4.6b, 4.6c* and *4.6d* illustrate the results.

Figure 4.6a: Survey 2:Q9:1. (Attitudes to Using Computer Analysis)



Taking into account the results shown in *Figure 4.6a* and *Figure 4.6b,* the therapists expressed a high level of interest in computational analysis, but their interest was clearly cautioned with uncertainty. Understandably, having not been introduced to the tool, some therapists perhaps wondered if it would be helpful to them, or create problems.

Figure 4.6b: Survey 4: Q9:2. (Attitudes to Using Computer Analysis)

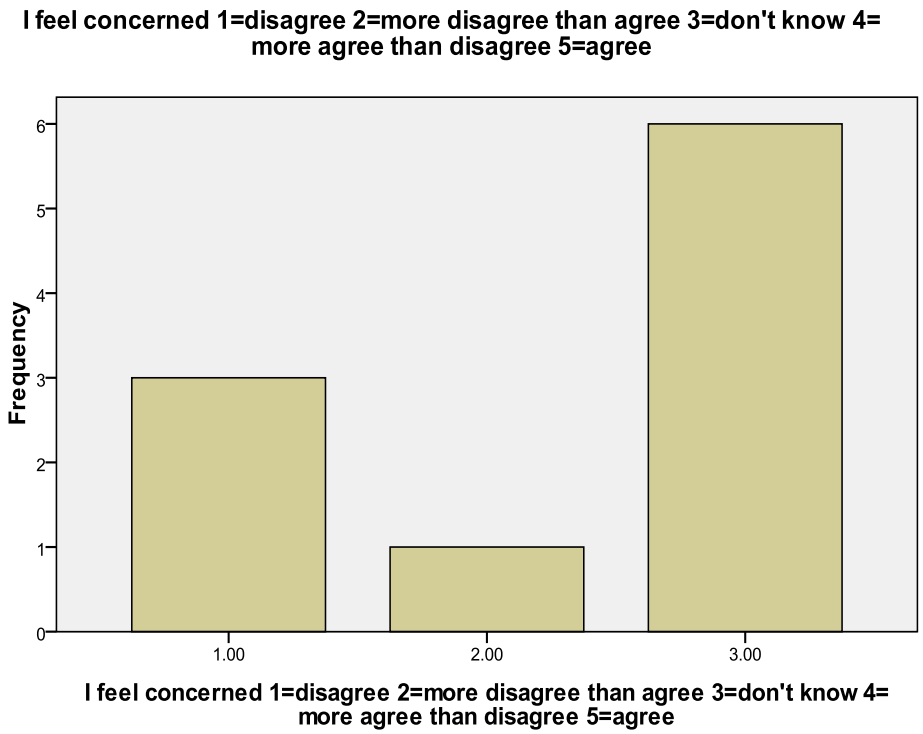
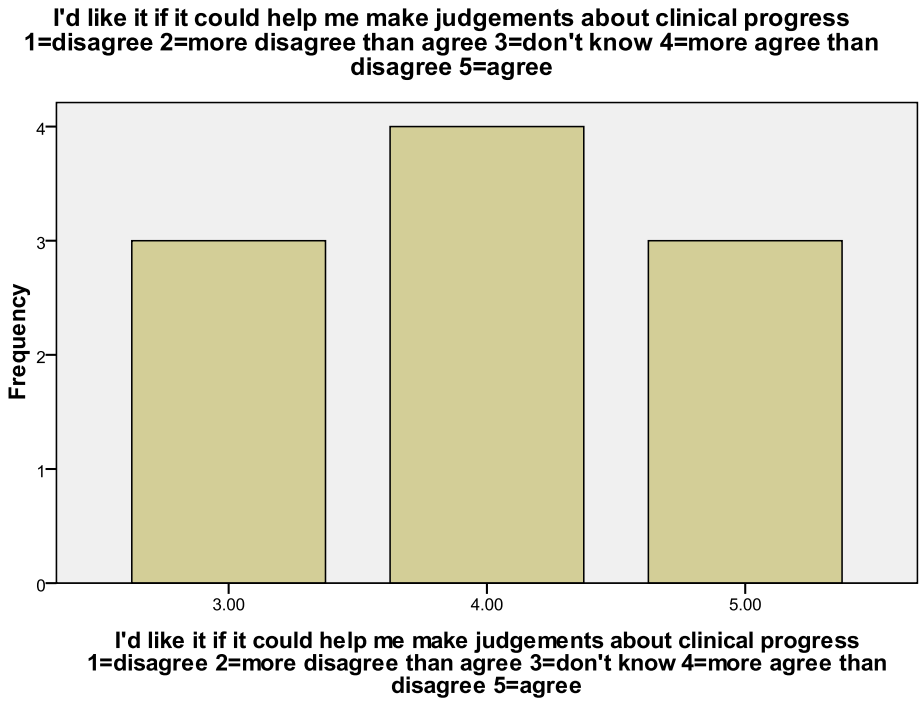


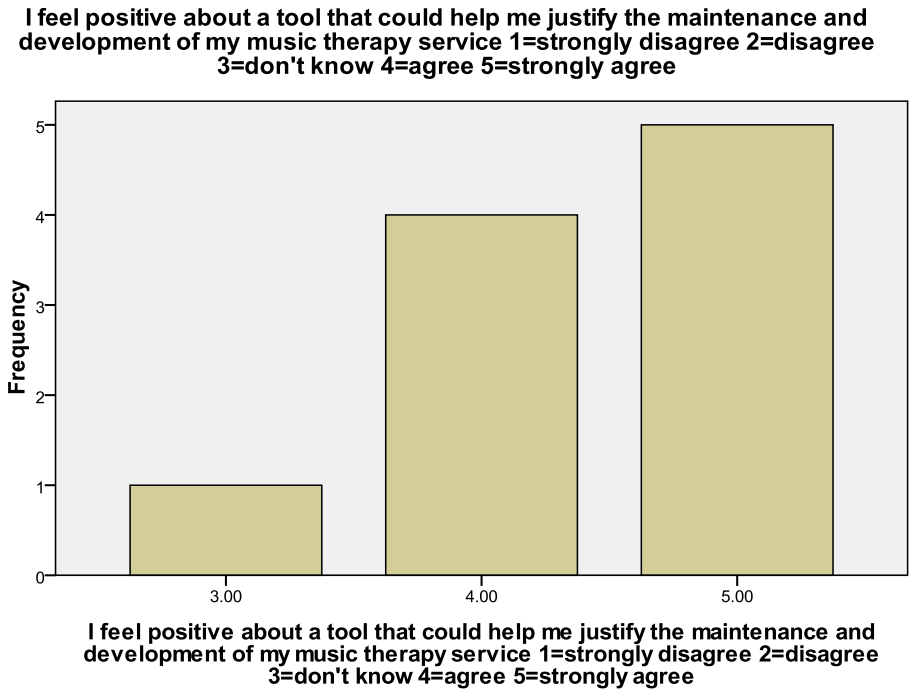
Figure 4.6c: Survey 2: Q9:3. (Attitudes to Using Computer Analysis)



The majority of therapists felt less uncertain about the prospect of being helped to make judgements about clinical progress (see *Fig 4.*6c above). Seventy percent of the therapists expressed interest if the tool could help address the question of patient progress. The results perhaps reflect the desire for a tool that can help them measure progress but also concern about whether a computer program will really meet their needs.

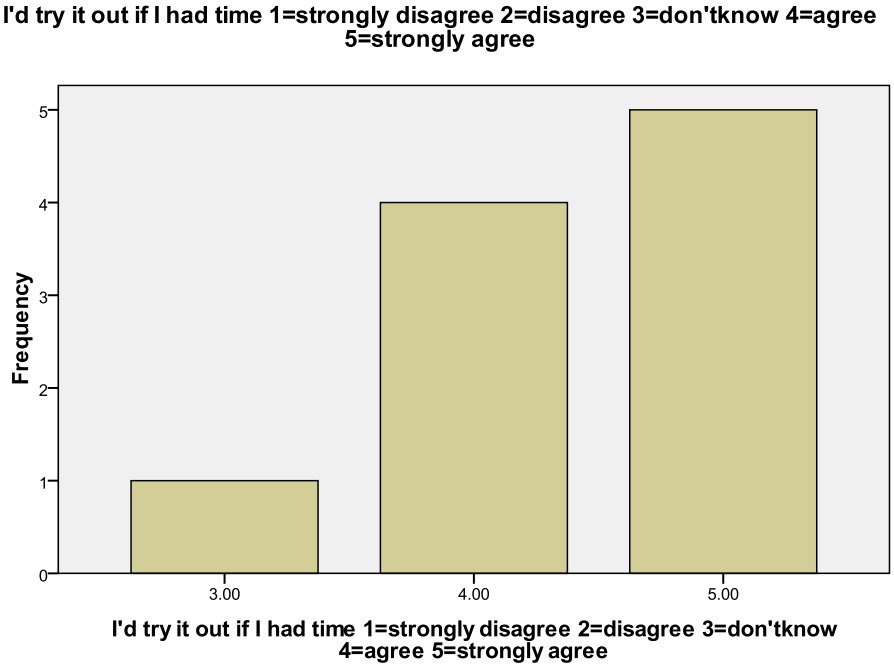
Figure 4.6d indicates that 90% of the therapists felt positive about a tool that could help them justify the development and maintenance of their services.

Figure 4.6d Survey 2: Q9:4. (Attitudes to Using Computer Analysis)



These results perhaps reflect something of the pressure music therapists are faced with in trying, in the first instance, to establish a service and then to maintain it given the evidence-based health service approach. However, the results would seem to suggest a high level of genuine enthusiasm from this small group; *Figure 4.6e* indicates that 90% of respondents reported they would like to try out the tool if they had time:

Figure 4.6e Survey 2: Q9:9. (Attitudes to Using Computer Analysis)



Respondents were then asked about the frequency of making recordings of sessions and preferences for audio or video recording *(*see *Figures 4.6f and 4.6g).* The therapists were asked to rate infrequency of recording sessions, rather than frequency of recording, and to rate a preference for video rather than audio. In this way the author wanted to ensure that recording was not being posed as an overly positive idea and a preference for audio was not being suggested. From the results in *Figure 4.6f* it can be deduced that at least 50% of the therapists record their sessions not infrequently, but that many were uncertain as to how to answer the question.

The therapists' preferences for using audio or video recording reveal a high level of uncertainty. One therapist who chose *don't know* reported that any preference would need to be patient specific. She wrote; *'This depends on a number of factors. For example – can they consent rather than what I would prefer?'* Here the therapist refers to the fact that some patients are either unable or unwilling to give consent for either type of recording, (though audio recording can sometimes be more acceptable).

Figure 4.6f: Survey 2: Q9:7: Frequency of Recording/ Attitudes to Future Use

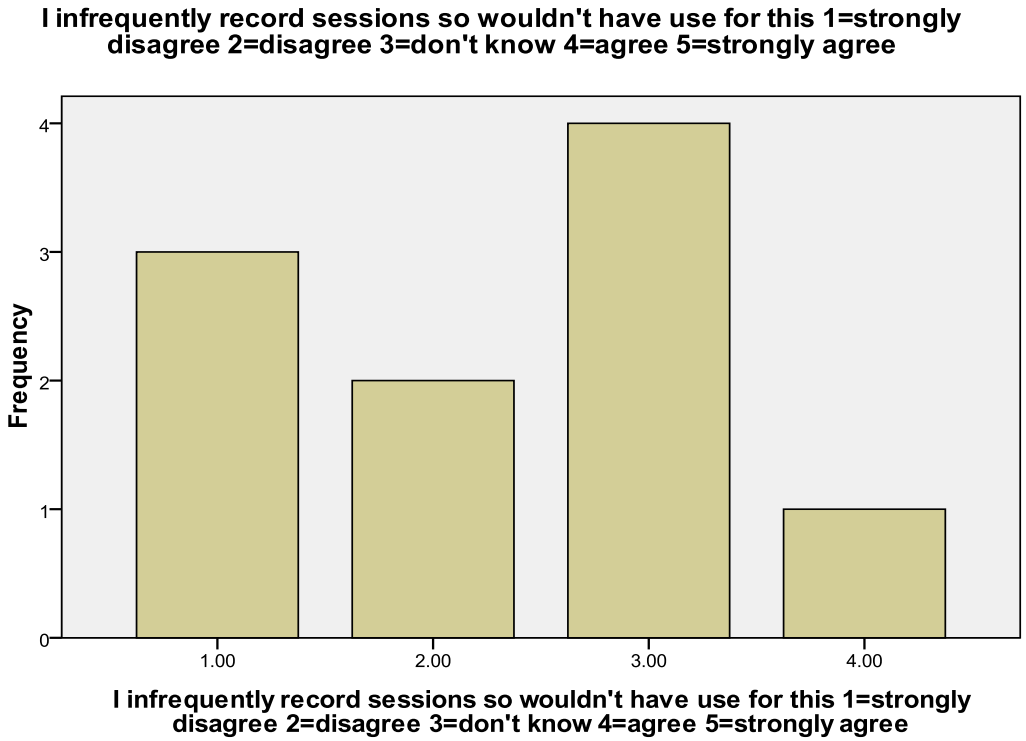
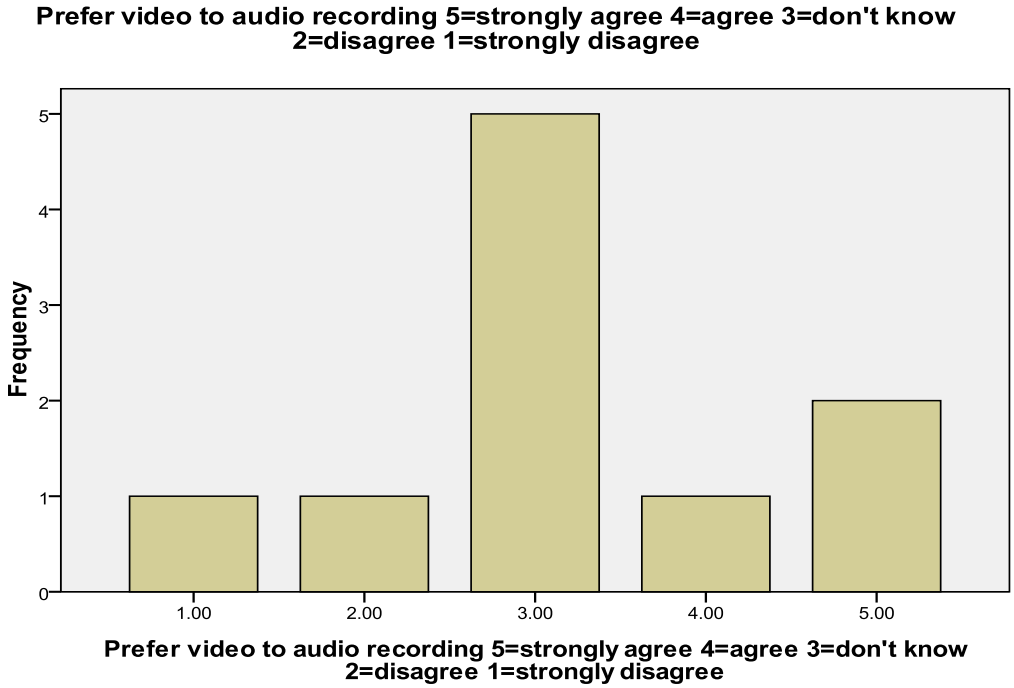


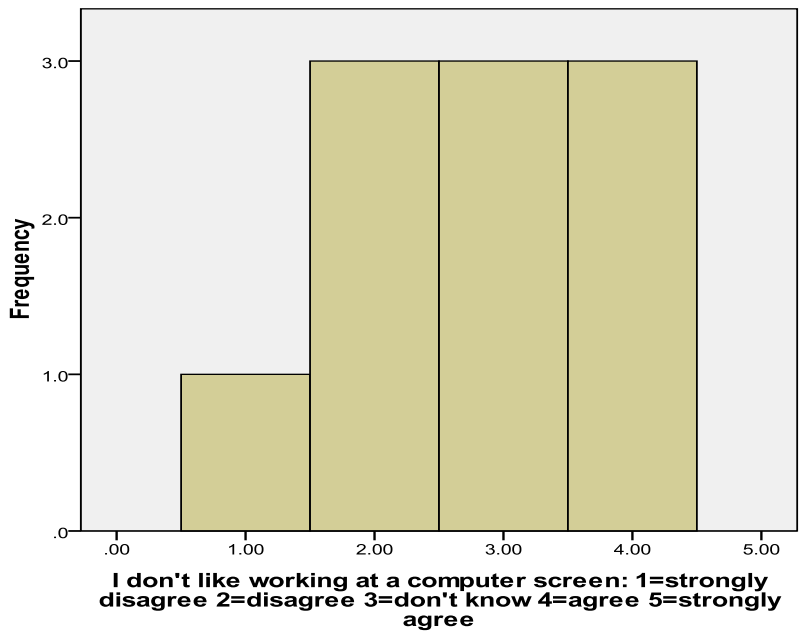
Figure 4.6g: Survey 2: Q9:8: Recording Preferences: Video or Audio?



Clearly, it cannot be argued from these results that this group of therapists expressed a preference for audio recording over video recording; only two out of ten therapists expressed a clear preference for audio whilst three therapists preferred video. The question arises as to whether music therapists are likely to invest in a system that only delivers audio recording if they also use video recording and may prefer this to audio. A system that can allow a preference to be made at the point of recording would seem to be the ideal solution.

As the Music Therapy Logbook system will involve the use of a computer, therapists were asked about working at a computer screen. Ninety percent of the therapists indicated they have access to a computer at work; 20% were using it on every working day, 50% used it on most days, and 20% used it infrequently. The results shown in *Figure 4.6h* indicate a spread of opinion as to whether or not this group of therapists like working at a computer screen. The minority expressed an actual dislike of working at a screen.

Figure 4.6h: Survey 2: Attitude to Working at a Computer Screen



The next question asked about attitudes to using a personal listening device (such as the i-Pod) for personal enjoyment. Nine out of ten therapists reported using this kind

of device for personal enjoyment outside of work. However, the one therapist who expressed a dislike for such devices also expressed a strong likelihood of using the music therapy evaluation tool in future. At the end of the survey the respondents were asked for comments. Fifteen comments were recorded from six therapists. *Figure 4.7* shows the key themes arising:

Figure 4.7: Survey 2: Key Themes from Therapists' Feedback

Ease of Use	Functions	Cost	Confidentiality
'It must be easy to use.'	'Good if it could incorporate video.'	'Would music therapists be able to afford to buy it?'	'Can we turn it off easily, if, say, a client doesn't want their talking recorded?'
'Must consider time we'd have to set aside to learn how to use it / train others to use it.'	'Most interested in quick method of objectively identifying changes over time.'	'We'd have to get the buyers on board.'	'It must be a secure enough system to store confidential data for a sufficient time.'
'Setting up the equipment - how long would that take?'	'Very useful if used alongside human analysis.'		
'How much time would it take to input the data?'	'Computers cannot recognise emotions'		
'Will the program be too complex to use?'	'What if there's a break in the session – how would it cope?'		
'It must be unobtrusive - clients can find equipment off putting.'			

Most comments (6 in all) concern *ease of use*, particularly in relation to the time available; e.g., how long would it take to learn how to use the system and how much session time would be used up by setting up the equipment? Included in *ease of use* comments was a concern as to whether or not the equipment would be off-putting for the patients and whether it would be too complex to use.

These comments seem to suggest that therapists don't want their thinking and preparation time used up, nor can they afford the time to engage with complex systems. The message seemed to be that therapists work to very tight deadlines and are already dealing with complexities, related to the nature of their job.

The second set of comments (5 in all) raised important issues about functionality; the potential inclusion of video, the value of gathering objective data, and being able to use this alongside human analysis. One commentator was concerned that a computer cannot identify changes in emotions and reported feeling *'sceptical about feelings between two people being able to be picked up by computer analysis'*. The comment suggests this therapist hadn't been given sufficient information about the proposed system, since the purpose of it is not to analyse emotions.

The third set of comments (2 in all) concern the potential cost implications; only two respondents commented on this aspect. One left a comment from the point of view of an individual, wondering whether an individual would be able to afford such a system. The other commented from a management perspective – *'We'd have to get the buyers on board'*.

The fourth set of comments (2 in all) concern the need to protect patient confidentiality. One therapist wondered how long the data could be stored, particularly if storage involved the use of CD Roms, (she reported experiencing problems with storing data for long periods using this format). Another wondered how the system would cope with a break in the session - would the therapist be able to leave the system safely running if they had to leave the session (for example, if the patient suddenly decided to leave the room and they needed to follow the patient.)

Summary of the Results of Survey 2

The majority of the therapists who returned survey 2 were working with severely disabled patients who had received head injuries, yet only two therapists were using outcome measurement scales to monitor their sessions, meaning the majority were unable to systematically monitor their work (at the time the survey was completed). Just five of the therapists indicated that their place of work required them to fill in a standardised session report form for each music therapy session delivered, so that clearly employers' requirements did not necessarily match the stricter guidelines of the Health Professions Council at this time for systematic evaluation.

Given the fact that the therapists had not been introduced to the tool in detail but had received a simple description of the functions the tool is likely to be able to achieve in future, their overall response to the concept of the Music Therapy Logbook system was positive. Ninety percent of the therapists reported that they were more likely than not to make use of such a system in future. The mean rating for potential future use of the system was 77%. The comments left by six therapists were reduced to four key issues; ease of use was the main concern.

4.5.1. Survey 3: Introduction

Based on feedback from the previous surveys, a more detailed survey was constructed to scope information from a larger group of international music therapists. The survey included 14 closed questions and 3 open questions (so that respondents could again offer feedback and suggestions). Therapists were asked to rate their likelihood of using such a tool in the future and to rate the computer analysis functions being investigated in this study. They were also asked their views on other analysis functions, potentially available in the future. (To view Survey 3 please refer to Appendix 2, page 227.)

Survey 3 questions were designed to elicit information on:

- Clinical conditions the therapists treat
- Current methods for monitoring and evaluating music therapy
- Gender bias affecting interest in computer aided evaluation
- Level of interest in computer aided analysis tasks
- Feedback on suggested analysis tasks (and any other comments)
- Issues that might deter therapists from using computer aided evaluation

Therapists were asked to rate computer aided *patient progress analysis tasks* as well as *therapy process analysis tasks*. The term *progress task* refers to those types of analysis functions which aim to track changes in the patient's use of music over time. The term *process task* refers to analysis tasks designed to enable the therapist in gathering information about the effect of their musical interventions on the patient's use of music.

4.5.2. Survey 3: Respondents, Return and Drop out Rates

Respondents

In order to compare the results with those of Survey 2, Survey 3 gathered opinions from international music therapists working in the neuro-disability field. It was decided to survey therapists (working in this field) who were already using computers regularly, since this would exclude opinions from therapists who would be unlikely to make use of computational analysis in future.

The survey was sent out by email attachment to members of the International Music Therapy Neurology Network (by the coordinator of the network, Dr Wendy Magee, who received instructions from the author). The geographical spread was as follows: 16 music therapists from the USA, 16 from EU countries (including 7 from the UK), 6 from South America, 3 from Australia and 3 from Canada. EU countries included Ireland, The Netherlands, Germany, Denmark, Latvia and Italy. Forty-seven percent of therapists were working full time, 43% were working part time, one was a trainee under supervision, two were retired members who had worked with such patients in

the past and one was a full-time university lecturer with previous experience of clinical work in the field.

Gender of Respondents

Twenty-five percent were male, 75 % female.

Response Rate

275 questionnaires were sent out; 42 questionnaires were received back by email attachment and two by post, giving an overall return rate of 16%. All 44 returnees identified themselves as qualified music therapists so that the return rate, although low, was more representative than it would have been had non-music therapists responded. (Not all members of this network are music therapists.)

Drop Out Rate

The drop out rate was 0. All questions that required answer selections were answered.

4.5.3. Survey 3: Current Methods of Evaluating Music Therapy Sessions

Therapists were asked about their evaluation methods. They were given a list of methods to select and an option to describe other methods not listed. *Figure 4.8* illustrates that, as with previous surveys, report writing was the predominant method used for monitoring clinical work. Written reports were reportedly more used than writing brief descriptive notes after each session, although this method was clearly important to the therapists.

Systematic note writing for describing each session, using the same format, was used by a minority; this reflects the relatively infrequent use of systematic evaluation reported in Surveys 1 and 2.

Figure 4.8: Survey 3: Methods Used by Music Therapists for Practice Evaluation

Methods of Evaluation	***Number of Therapists Using Method***
Writing assessment notes	39 (88.6%)
Writing case conference reports	36 (81.8%)
Brief notes shortly after the session describing what happened	31 (70.4%)
Writing ward notes	29 (65.9%)
Recording the session using video equipment	28 (63.6%)
Watching video recordings and taking notes	22 (50.0%)
Recording the session with audio equipment	21 (47.7%)
Categorising information contained in video recordings	17 (38.6%)
Playing an instrument or singing	17 (38.6%)
Listening back to audio recordings and writing notes	16 (36.3%)
Systematic note writing using the same format for each session described	14 (31.8%)
Use of musical notation to describe events	12 (27.2%)
Listening back to audio or video then writing down musical notation	11 (25.0%)
Categorising information contained in audio recordings	10 (22.7%)
Counting musical events in audio or video recordings	9 (20.4%)
Other*	5 (11.3%)

[* 1 = MTh standardisation evaluation tool (not named). 1= Therapist's own pre-post client self-assessment form. 1 = Use of Creative Music Therapy scales and AeMT. 1 = Metronome software (not named). 1 = Sonogram analysis and spectrum analysis (neither were named).]

These results lend weight to the view that whilst music therapists increasingly express the need for systematic methods, systematic treatment evaluation is not well established. For example, Aigen's (2008) analysis of 56 doctoral research studies using qualitative methods identified eleven whose topic centred on music therapy treatment evaluation and 1 on music therapy assessment, (Aigen, 2008, p.253).

In addition, therapists were asked whether they used published outcome measures to describe progress in music therapy. Eight therapists reported that they did use such measures and twenty seven therapists reported they were required to fill in a standardised report form. It would seem likely, therefore, that for the majority of these therapists' patients, objective data, systematically derived from their active music making, did not feature significantly in treatment reports or outcome measurements.

Of particular relevance is the data on the therapists' use of video and audio recording. The majority of therapists reported using video to record their sessions (64%). However, only 50% of respondents reported viewing video and writing notes. Categorising information from video recordings was less reported – only 38% of therapists reported this. Similarly, 48% of respondents reported recording with audio, but only 36% reported listening back to audio and taking notes. Lowest was the systematic analysis of audio recordings: 23% of the therapists reported categorising events from audio recordings.

Of the therapists who reported reviewing recordings in depth, by categorising *events*, the data showed that both audio and video recordings were used as a means of monitoring therapy sessions.

The term 'event' was not defined for the respondents. However, the results indicate that the events being categorised in video review were likely to include non-musical event types as well as musical event types; for only 20% of the whole sample reported *quantifying musical events* from either audio or video recordings whilst 38% reported categorising events from video. The results shown in *Figure 4.9* would seem to support this view.

Figure 4.9: Survey 3: Use of Video and Audio Recordings for Evaluation

Method of Evaluation	Number of Therapists Using Method
Listening back to audio recordings and writing notes	16 (36.3%)
Counting musical events in audio or video recordings	9 (20.4%)
Categorising information contained in audio recordings	8 (20.0%)

In order not to suggest that audio recording might be preferable to video, respondents were requested to rate the following statement on a sliding scale from 1-5, with 5 as the highest level of agreement: *'I prefer recording sessions using video rather than audio'.* The majority of therapists indicated they were unsure as to their preference, closely followed by a group who preferred video. Those preferring video to audio recording (34%) were in the minority; those who disagreed with the statement combined with those who did not know their opinion constituted a majority, 61% of the sample.

4.5.4. Survey 3: Therapists' Opinions of Proposed *Patient Progress* Analysis Tasks

By this time in the user opinion study, a number of computer analysis techniques had been identified as potentially useful and technically possible. It was therefore relevant to ask the Survey 3 therapists whether they would be likely to use these techniques in future, (if and when they become available). The author referred to these techniques as *progress analysis tasks.* Survey respondents were asked to rate the tasks in terms of 'usefulness in helping you evaluate patient progress'. The therapists were given a brief case description of a hypothetical patient and asked to rate the progress analysis tasks based on the patient's history and presenting condition:

'Jo' had a stroke 3 months ago. She is 46, married with a young daughter and works in a radio station. She has lost most of her expressive speech and is in a wheel chair. She can indicate 'yes' and 'no'. Her speech is beginning to recover and she is receiving physiotherapy. Jo's preferred instrument is the conga drum.

Respondents were asked to rate seven progress analysis tasks in terms of how useful they would be in helping them evaluate their work with 'Jo'. First they were asked to rate the usefulness of measuring the duration of each session then measuring the amount of silence in each session, tasks that a computer can easily achieve. Sixty percent of therapists rated quantifying changes in the patient's silence as useful and 32% rated it very useful. They were less convinced that measuring the duration of the session would be relevant; 57% rated this as useful. In contrast, the results shown in *Figure 4.10* indicate that analysis of key musical events related to the patient profile was considered more useful — in Jo's case, identifying changes in the patient's use of her voice and monitoring her use of a preferred instrument, the conga drum.

Figure 4.10: Survey 3: Therapists' Opinions on Quantifying Changes in Patient's Vocal Sounds, Sung Words and Preferred Instrument

Vocal sounds: *'How useful would it be if the program could quantify (count) the number of times Jo made vocal sounds?'*

Sung Words: '*How useful would it be if the program could quantify (count) the amount of time Jo spent singing words in each session?'*

Conga playing: *'How useful would it be if the program could measure the amount of time Jo spent playing the conga in each session?'*

	Never Useful	**Rarely Useful**	**Sometimes Useful**	**Useful**	**Very Useful**	***Useful + Very Useful***
Sung Words	0%	4.7%	0%	9.3%	86%	***95.3%***
Vocal Sounds	2.5%	5.0%	0.0%	17.5%	75.0%	***92.5%***
Conga Playing	2.5%	7.5%	5.0%	25.0%	60%	***85%***

Clearly the respondents regarded the ability of a computer program to quantify changes in the emergence of sung words and vocalisation as extremely useful to them (in the context of treating patient 'Jo'.)

Figure 4.11 shows the therapists' mean ratings for all of the progress analysis tasks described in the question. (They were asked to rate all of the patient progress analysis tasks in terms of how useful they would be in helping them evaluate music therapy with patient 'Jo'):

Figure 4.11: Survey 3: Mean Ratings of Patient Progress Analysis Tasks.

Proposed Patient Progress Analysis Tasks	**Mean Score out of 5**
Quantify patient's sung words	4.77
Quantify patient's vocalisations	4.58
Identify most sustained passage of patient's drumming and identify in which session it occurred	4.44
Display a diagram describing increase /decrease in patient's time spent playing conga drum over 10 sessions	4.35
Measure amount of silence in each session	4.34
Measure duration of patient's playing on one instrument	4.33
Measure duration of sessions	3.65
Therapists' Mean Rating of All Proposed Progress Analysis Tasks	*4.35 (87%)*

(N=44. Number of therapists who rated tasks =44)

The results show that, as a group, the therapists' ratings match to the treatment goals they would be likely to have for such a patient. For example, stimulating Jo's recovering speech; first through rhythmic play, then non verbal singing, then singing words (with the aim of helping her recover her means of communication.)

However, it needs to be pointed out that there is relatively little difference between their evaluation of the top task in terms of its usefulness in helping them evaluate music therapy with 'Jo' as compared with the lowest rating they awarded to measuring the duration of the sessions. As a group they seemed enthusiastic about all of the computational analysis tasks proposed.

4.5.5. Survey 3: Therapists' Opinions of Proposed *Therapy Process* Analysis Tasks

These questions asked therapists to rate statements describing particular functions to help them a) monitor the effects of their music choices on the patient's use of music, and b) keep track of subjectively selected musical events — monitoring *process* rather than *progress*. Again, the therapists were asked to rate the tasks in terms of their usefulness in helping them evaluate music therapy with 'Jo'.

The statements covered the main uses of the prototype system to be investigated or tested during the project — for example, mapping tempo correlation between therapist and patient to see what effect the therapists' tempo has on the patient's.

Overall the therapists rated the usefulness of the therapy process analysis tasks only slightly lower than they rated the patient progress analysis tasks. *Figure 4.12* shows a summary of the therapists' ratings. (N.B.A specialist music therapy evaluation system will always be limited to enhancing answers to therapists' process questions; these analysis tasks are not intended as a substitute for self-reflection, personal note writing or supervision but as a possible aid to those procedures.)

Figure 4.12: Survey 3: Mean Ratings of Therapy Process Analysis Tasks.

Proposed Therapy Process Analysis Tasks	**Mean Score out of 5**
Computer retrieves and can play back therapist's tagged events (therapist tags events whilst listening to playback)	4.41
Tempo correlation mapped between therapist and patient	4.33
Writing notes whilst listening to audio play back (notes date stamped and stored with audio recordings)	4.16
Therapist able to listen back to patient's instrumental audio track without hearing their own and vice versa	4.15
Identify changes in dynamic range of therapist and patient	4.13
Track ratio of therapist to patient instrumental playing	4.05
Therapists Mean Rating of All Therapy Process Analysis Tasks	*4.20 (84%)*

(N=44.Number of therapists who rated tasks =44)

Seven, out of the 44 therapists who completed Survey 3, rated their likelihood of using a computer-aided evaluation tool below 50%. (All seven were female.) They were asked to match their opinions to a list of potential reasons and offer other reasons if theirs were not listed. In line with comments contributed in previous surveys, it is clear that time restraints at work were central to these therapists' concerns: Five out of seven therapists selected the answer *'I would not have time'*. One of these therapists also reported preferring video to audio recording and two reported that their patients do not want to be recorded. The remaining therapist

reported that, '*As I do not use the Nordoff-Robbins method, I am not interested in monitoring these kinds of changes'*. This would seem to imply the therapist is of the opinion that only those who are trained in the Nordoff Robbins method would be interested in monitoring changes in music over time.

4.5.6. Survey 3: Gender Influences on Attitudes to Use

A limited investigation was undertaken concerning gender influences on attitudes to future use of the evaluation system. *Figure 4.13* compares how female and male therapists reported the likelihood of their future use of the tool:

Figure 4.13 Survey 3: Attitudes to Future Use of the Tool – Gender Differences

Likelihood of Use	N	Range	Minimum	Maximum	Mean
percentage likelihood of using tool if available now	44	94.00	6.00	100.00	73.54
percentage likelihood of male therapists using tool	11	21.00	79.00	100.00	91.90
percentage likelihood of female therapists using tool	33	94.00	6.00	100.00	67.42

The results show that male therapists displayed a consistently higher level of confidence in their opinion, whilst the larger female group showed a wider spread of opinion. As female therapists were 2/3rds more prevalent, their wider spread of opinion was to be expected. However, these results pose questions as to whether women are likely to be less interested than men in using such a tool in future. Perhaps they have less time available (in which to learn new technology)? Perhaps they are more cautious of the impact of computational analysis on their practice? Perhaps they feel unconfident using technology? As female therapists are in the majority, it was important to try to understand more about the gender influences underlying these results.

Attitudes to future use were further investigated as follows. First, by correlating the gender of the respondents with answers to Question 11 (Survey 3); this asked therapists whether they enjoyed using devices, such as the iPod, for personal listening. *Figure 4.14* indicates that 55% of the female therapists reported enjoying the use of such devices as compared to 82% of the male therapists.

Figure 4.14: Survey 3: Gender Influences on Using i-Pod or Similar Device

Q11.Do you like using an i-Pod (or similar device) for personal enjoyment? Yes=1 No=2
male = 0 - female=1 Cross tabulation

Count

		male = 0 - female=1		
		0	1	Total
Q11.Do you like using an IPod (or similar device) for personal enjoyment? Yes=1 No=2	1.00	9	18	27
	2.00	2	15	17
Total		11	33	44

The results here show a very similar pattern to those illustrated in *Figure 4.13*: as a group, the women were less likely to enjoy using a personal listening device and less likely to use computational music therapy analysis in future. Again, it is not clear why this should be case, but it would appear to confirm a less enthusiastic attitude towards new audio technology.

The next approach was to analyse the general comments left by respondents in answer to question 16:

> *Q16. You may have feedback you'd like us to know about – please write in the box below. There may be things you feel are important that we haven't covered – all comments are welcome:*

Of eleven male respondents, 6 supplied comments (54.5%). Of thirty three female respondents, 13 supplied comments (39.3%). Four key themes emerged from an analysis of the comments. *Figure 4.15* shows the first three themes: *concerns* expressed, *analysis functions* offered, *usability* issues raised.

Figure 4.15: Survey 3: Concerns, Functions and Usability; Gender Attitudes

(Comments left by male music therapists are indicated in bold italics)

Concerns	**Functions**	**Usability**
'The computer would be an extra thing to carry.'	***'Suggest link the output to categories of World Health Organisation's International Classifications.'***	'I would need to be able to learn it with very little effort or I might not use it.'
'My biggest concern is I feel overwhelmed with technology I CANNOT KEEP UP WITH IT!'	***'Allow inclusion of information supplied by family members or staff concerning the patient's mood.'***	'The program should be easy to use and not take too much time.'
'My only concern is my lack of computer skills.'	***'Identify more musical elements of interaction and relating.'***	'We have very limited time and need to do record keeping very quickly.'
'I'm not sure I fully understand how this would work I am not very good with recording technology.'	'The more detailed the information - the more accurate the results.'	'I use Mac programs to record sessions because they are simple.'
'Will we be able to override decisions made by the computer, if something just does not feel right?'		'Sometimes having too many categories of data input can be a reason not to use a program.'
'What are the protocols and policies regarding the patients'/clients' and therapists' privacy concerns?'		
'There might be issues with confidentiality as far as recording sessions is concerned.'		
'Maybe companies could purchase but would this be too expensive for private practice? I'd have to persuade my employers.'		

Concerning these three themes, the female respondents mainly commented in terms of practical and ethical issues associated with introducing new technology at work: cost, protecting confidentiality, and the time they had available, both to learn the new system and use it within the time frame of their sessions. Less than half the concerns expressed by the female therapists related to lack of confidence in using new technology; of the thirteen comments left by the female therapists only three concerned this factor. Therefore of the 33 female therapists who responded to Survey 3, 9% expressed concerns about using new technology.

In contrast with these opinions, the male therapists left no comments describing either their concerns about the proposed system or the usability of the system – their comments did not reflect any of the practical or ethical issues raised by the female therapists. The male commentators only expressed opinions related to the functions of the proposed program.

In addition to the themes analysed above, a fourth theme was extracted from answers to Question 16; *positive excitement.* These comments have been extracted and all are individually shown in *Figure 4.16*. Just over half the men left comments compared with a third of the women.

Male therapists tended to express opinions concerning the overall development of the profession - how the technology might be important in helping build the profession in future. Two seemed to imply they understood the research as a race against time. One even gave his permission for the work to proceed.

The female therapists, whilst sharing the male therapists' excitement about the value of such a tool in building the profession, also viewed the technology as a means of explaining music therapy to others, assessing and improving their own performance. One suggested it could help raise standards.

The female therapists also pointed out that the technology would bring benefits to patients (or clients) as well as benefiting therapist users.

Figure 4.16 Survey 3:Q.16 - Positive Excitement (Male and Female Comments)

Positive Excitement : Male Therapists	**Positive Excitement: Female Therapists**
1. Congratulations!! Go ahead!	1. I am very excited about this and think it will be a great addition to the music therapy profession.
2. To have tools like these would be excellent. This work is crucial for the development of the profession. I am really excited about the questions being asked and the possible program that could develop.	2. This would be a huge benefit for music therapists, raise the standard of our work, thus providing greater benefit for the clients and also serve to validate the profession.
3. I'm very excited -a real support for providing evidence for the efficacy of our work	3. I am very excited I believe it will be a great benefit to music therapists and their clients.
4.This is a well needed tool coming at a great time in the development of the profession	4. I am glad to see that such a tool is being designed that will allow us to make objective observations and provide quantitative data.
5. This project is very important and Interesting.	5. Being able to analyse our work will benefit the clients and us. We will become aware of improvements *we need to make.*
6. Good luck with the development of this very useful clinical tool	6. We will make better informed decisions regarding goals, objectives and assessments
	7. It is very positive that this software might provide means of providing quantitative data to share with funders.
	8. I think this idea is brilliant. Any tool that allows us to better observe, document, and communicate session proceedings in an objective and replicable way will surely be of benefit.
	9. I think this program would be excellent for validating Music Therapy to other professionals, in particular the medical community
	10. Due to the level of analysis this could raise standards within the profession.

Conclusion on Attitudes to Future Use Affected by Gender, Survey 3

These limited investigations seem to point to differences in attitudes between the male and female therapists who returned Survey 3.

The results suggest that for this group of music therapists, the men were excited about the prospect of a tool which would benefit the profession and which they could easily imagine using, whereas the women, also sharing the excitement, kept in mind a range of practical and professional issues that would affect the use of the tool, in particular the time factor involved in learning the new technology, and implementing it. The female therapists mainly viewed the technology as potentially very useful — but only if certain conditions are met.

4.5.7. Survey 3: Summary of Survey 3 Results

Overall, the mean score for the likelihood of these respondents (N=44) using the computerised evaluation tool in future was found to be 74%. This was a similar finding to that of Survey 2 (N=10) in which the mean rating for future use of the tool was 77%.

Therapists rated the computational analysis tasks higher than they rated their prospect of using the tool in future. The results at first seemed to indicate that lack of time may be a significant deterrent in using a computer-aided evaluation tool. However, of the five therapists who indicated they would be unlikely to use the tool because they didn't have time, four gave high levels of agreement with the statement: '*If I had time I'd like to try out a tool like this*.' It is interesting to note that of these five therapists, four were working full time. Although this data is derived from a small sub-group of respondents, and therefore these results cannot be regarded as significant, the results again raise the question as to whether music therapists who work full time have less time available for evaluation than those who work part time.

The respondents rated *patient progress* analysis tasks only slightly higher (87%) than *therapy process* analysis tasks (84%). This was a useful finding because the development of a tool that can both help evaluate patient progress and help therapists

monitor their musical interventions, and the effects of those interventions, is important. The balance between evaluating progress and process is vital in establishing systematic evaluation methods that take into account both these interdependent factors.

The feedback was extremely useful; excitement was cautioned with the practical realities that need to be addressed, particularly for the female user group. 2/3rds of respondents expressed interest in keeping in touch with the research.

4.6.1. Introduction to Survey 4: Factors Influencing Interpretation of Results

Survey 4 was sent via a web link; respondents accessed the survey by selecting a link in an email message that took them straight to the on-line questionnaire. After completing the survey, the respondents submitted it on-line. (The survey 4 collection and analysis was administrated separately by a Survey Monkey account.) It is important to question whether the results of a web survey can be said to be representative when low response rates occur (Groves 2006). Current research indicates that attracting a high number of respondents does not imply the ensuing results will be more representative. For example, the research guidelines set out by the American Association of Public Opinion Research (AAPOR) state that;

> Census or very large governmental sample surveys have questioned the positive association between response rates and quality (*in web surveys*). Furthermore, a growing emphasis on total survey error has caused methodologists to examine surveys—even those with acceptably high response rates—for evidence of non-response bias. Results that show the least bias have turned out, in some cases, to come from surveys with less than optimal response rates. Experimental comparisons have also revealed few significant differences between estimates from surveys with low response rates and short field periods and surveys with high response rates and long field periods. (AAPOR 2010)

AAPOR advises that results are more likely to be representative of a population as a whole if the following factors have been taken into account: i) every person in that

population has been given a chance to respond, ii) the population being surveyed has been carefully chosen by the researcher to be relevant to the study, and, if necessary, randomized, iii) the results of the survey are similar to the results of other surveys carried out at a similar time, iv) respondents are prevented from completing the survey more than once, v) the survey design is made available along with the results. Bearing in mind the importance of publishing the research design along with the results, a description of relevant factors (outlined by AAPOR affecting the quality of results) is presented below.

Population Surveyed

The invitation to participate was sent out to professionally trained music therapists in the UK by the administrator of the Association of Professional Music Therapists UK, who had received instructions from the author, (herself a registered member). At this time there were 693 registered members and 677 of these had chosen to receive information from the Association by email. As the ratio of non-email users to email users was very high – 1:1.03 – it was unnecessary to randomize a sample from the email user group. Six of the messages bounced back, so that the final number of therapists who were sent the survey web link numbered 671. The ratio of non-email users (those who never received the survey) to email recipients was therefore 1:1.04.

A minority of the therapists who were sent Survey 4 had returned the previous surveys: ten UK therapists had previously responded to Survey 2, and seven UK therapists had responded to the international survey. It was assumed that these UK therapists were very likely to be members of the Association of Professional Music Therapists, UK. Therefore, out of the 125 respondents who returned Survey 4, a possible maximum of 14% may have previously returned a questionnaire on the subject. Therefore, Survey 4 questions were designed to be notably different from those contained in previous surveys.

Response Rate / Drop Out Rate / Field Length

The survey was designed to be reasonably quick to fill out (about five minutes) and to be confidential, so that the respondents could not be identified. Since 125 therapists

submitted a survey return, the response rate was 18.5% of the total number of therapists who received the web link and 18% of the APMT membership. This was similar to the 16% return rate for survey 3 and thus allows a meaningful comparison of results. There was a 100% completion rate of Survey 4 (as there had been for Survey 3) and therefore a 0% dropout rate. Survey 4 contained two questions. Question 1 was answered by 122 respondents. Question 2 was answered by 124 respondents. Therefore the dropout rate for both questions was negligible (as was the dropout rate for survey 3 questions). There was a short field length; the survey was open for four weeks. No reminder was sent during that period.

Controlling Responses from each Computer

It is known that some music therapists work from shared offices, where more than one music therapist may have wanted to return the survey questionnaire by web link.
It was therefore decided not to limit the returns to one per computer because this would have limited the chosen population's access to returning the questionnaire and therefore interfered with analysing the data. (It was thought very unlikely that a qualified professional would return the survey questionnaire twice in order to influence the overall results, or forget that they had already returned it.)

Comparability of Results

By running a fourth survey, sent to a larger group of therapists, the aim was to compare UK music therapists' general attitudes with results from the previous surveys. Bearing in mind that surveys 3 and 4 were both administered by email and had similar levels of return and break-off rates, it is possible to conjecture that any similarity of opinion between them is likely to indicate a fairly good representation of music therapists' opinions. However, this statement needs to be tested against further survey returns from other national groups. (Two follow up surveys are being administered by international colleagues at this time, Professor Thomas Wosch (Germany) and Dr Avi Gilboa (Israel). For reasons of time it is not possible to include these results in the thesis but they will be published later.)

4.6.2. Survey 4: Design

Survey 4 aimed to scope

- UK therapists' general level of interest in using a specialist computer program to analyse audio recordings of music therapy sessions in order to help them evaluate their practice
- UK music therapists' opinions on the relevance of analysis functions already tested or under investigation
- Comments and suggestions.

The introductory page informed respondents that a software program was being developed to help them monitor changes in their patient's musical playing in relation to their own by analysing audio recordings of music therapy sessions. They were also informed that video analysis was being considered. Question 1 asked therapists to read a list of 10 potential analysis functions and select any they wanted included in an evaluation software program. Question 2 asked respondents to select any statements that matched their opinions concerning whether they would use such a program in future to help them evaluate their work. (To view Survey 4 please refer to Appendix 3, page 240.)

Unlike Survey 3, Survey 4 gave no specific example of how the Music Therapy Logbook program might be used in future or the likely make up of the Music Therapy Logbook signal acquisition system. The questionnaire listed potential program functions as statement choices, any of which the therapists could select (in any combination) in answering Question 1. This was in order that the therapists, whilst answering question 1, would gather an understanding of the kinds of functions associated with the proposed Music Therapy Logbook system. Two therapists (less than 2% of the whole group) left comments concerning the difficulty of answering questions when they had not been introduced to the program. One commented *'I would like to attend a workshop first and think more carefully about it, but potentially it may be very useful',* the other therapist commented; *'It is hard to make a decision having not seen or used the program.'* However, the great majority of therapists had

no difficulty in imagining why they would or would not be likely to use such a program. One therapist commented; *'This is the kind of stuff that it is impossible to find time to do in 'real life'.'*

A fifth of the therapists who responded to Survey 4 supplied additional comments. 61% of these were positive comments, for example: *'I would (use it) because I am already trying to do these things and it is very time consuming! Great if a computer can help with the hard data….*' Thirty-five percent of comments expressed ambivalence, and 4% of the comments gave negative feedback. (A discussion of the comments received follows the presentation of results).

4.6.3. Survey 4: Question 1

Question One: '*You are asked to evaluate how effective your work has been with a client seen for individual music therapy over a ten week period. Imagine you have recorded each of the weekly sessions on a specially designed system that allows an ordinary computer to store your recordings. Which of these functions (if any) would you want included in a computer program, designed to help you extract objective data about the client's changing use of music over the ten weeks?'*

Ten analysis function choices were listed in the following fixed order:

1. *Measure changes in the client's use of musical dynamics.*
2. *Quantify any increase or decrease in the client's non-verbal singing.*
3. *Identify and measure interactive episodes between the therapist and client (episodes when they are responding to each other by imitating each other's sounds).*
4. *Measure changes in the amount of time the client spent singing words.*
5. *Identify changes in the tempo of a client's percussion playing in relation to that of the therapist.*

6. *Create a diagram comparing how much time the client spent playing each instrument in each session.*
7. *Compare the amount of session time the therapist used for making sounds as compared with the client.*
8. *Create a diagram which maps the amount of time the client spent using instruments and voice over the whole course of therapy.*
9. *Identify repeated musical patterns or phrases and measure changes in their occurrence.*
10. *Measure changes in the amount of silence.*
11. *Other*

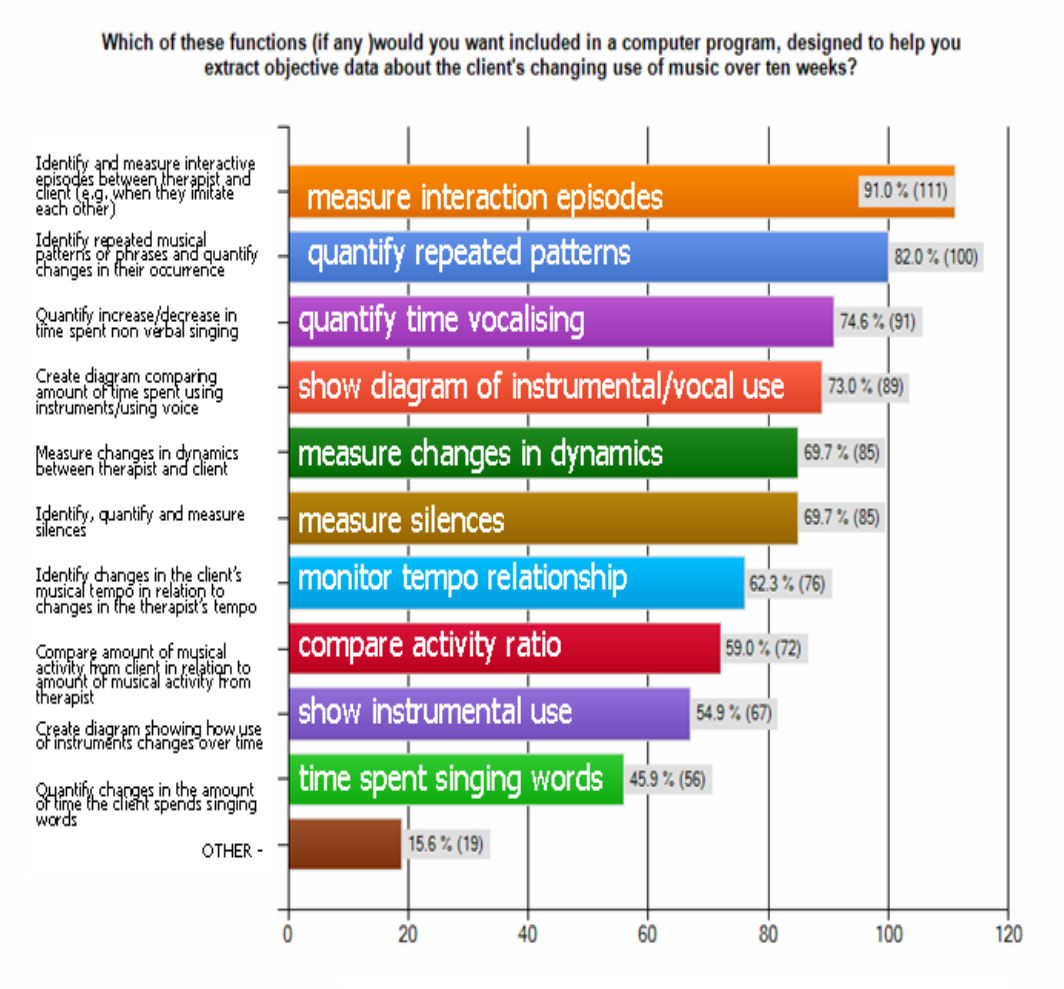
(N.B: Statement 3: It was decided to limit this description to a specific aspect of musical interaction – imitation – in order that respondents would be giving their opinions on the same aspect of interaction when selecting this as an answer choice. Of course musical interactions are made up of a number of complex events - as many of the therapists pointed out in their later comments.)

Choices 1, 5, 6, 7, 9 and 10 had already been proven technically possible by the time the survey was made available (Streeter 2008). Choices 2, 3, 4 and 8 were known to be technically challenging—likely to be technically possible in future, but not yet proven. (For example, it is not yet proven that the voice of the therapist and the voice of the client can be separately identified from a multi-track audio recording of an individual music therapy session. A discussion of possible approaches to solving the problem follows in Chapter 5.) The 'other' category of answer allowed therapists to make their own suggestions for analysis functions.

The function choices were presented to the therapists in a fixed order; this means that it is not possible to take questionnaire fatigue into account when analyzing the results. A decision was taken to create a fixed list because the author wanted to make sure similar choices were always kept separate—for example, those related to flexibility and fixedness (answer choices 3 and 9).

Figure 4.17 shows the main set of results:

Figure 4.17: Survey 4: Question 1 Results



Number of Therapists who Chose Each Analysis Type

The top preference was function 3; the ability of a program to search for passages of musical interaction then monitor changes in the duration and frequency of such episodes across a number of sessions. The opposite of interactive improvisation can be thought of as unresponsive, fixated sound making (either verbal, non-verbal or musical) which is rarely used for shared 'conversational' exchange (either in or out of music). The second preference was number 9: 'identify and quantify repeated patterns'. Perhaps the therapists were thinking of using this to detect musical fixation? Or they may have wanted to use it to identify a positive change; for example, being able to remember a phrase and repeat it involves the use of short term memory.

The two function choices were separated in the list so as to ensure both would be considered separately. It is interesting to note that nine of the 13 therapists who identified themselves as very unlikely to use the program (in answer to Question 2) selected both the interaction and phrase repetition analyses. It is therefore suggested that most therapists who returned the survey would like a system that can detect and measure changes in a client's musical communication with the therapist, not simply a system that measures changes in the client's music-making alone.

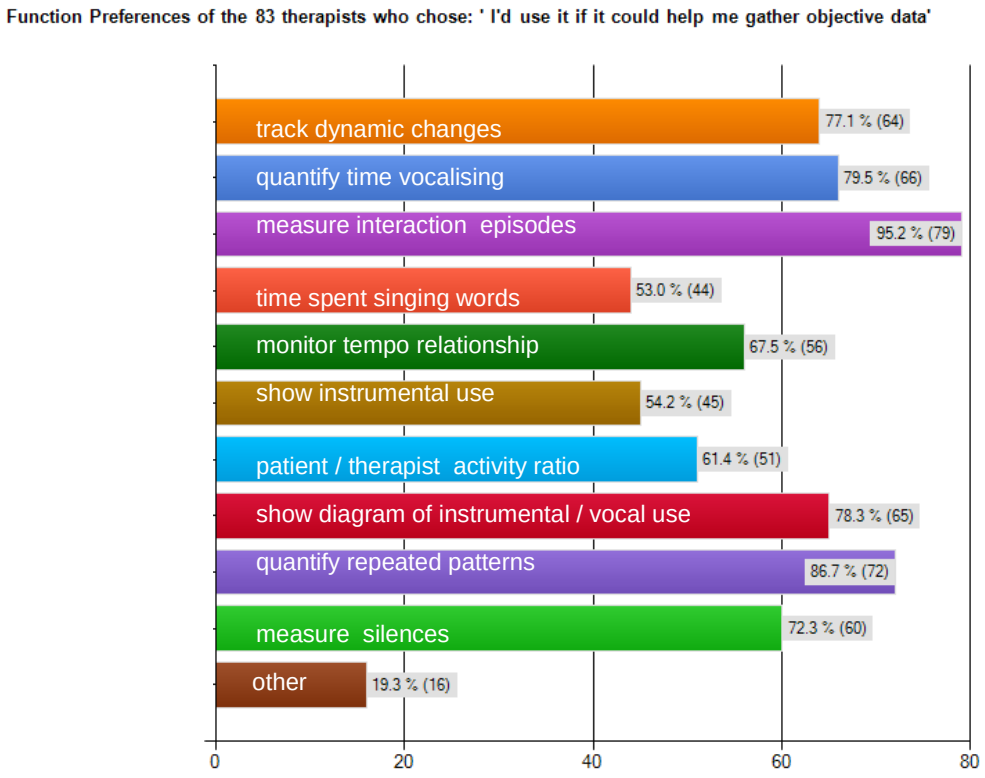
As a group, the therapists' Question 1 answer selections also imply a greater interest in monitoring the development of a communicative musical relationship than whether the client's ability to use words is improving. Less than 50% of the therapists wanted the computer program to be able to detect an increase in the amount of time the client spent singing words. This result differs from that of the survey 3 respondents, who rated the ability of the computer to quantify changes in the client's sung words very highly. There are two aspects here to take into account. Survey 3 respondents were given a description of a client and were asked to base their answers on the usefulness of different functions in evaluating work with that client. The client was described as gradually regaining speech after a stroke. Given this clinical context, the therapists understandably rated speech recognition very highly (since improvement of speech would have been one of the main functional treatment goals).

In contrast, the survey 4 respondents were given no case on which to base their answers. The group's relatively low interest in detecting sung words perhaps reflects the fact that music therapists often work with clients who have never developed speech, or through illness or accident have lost their capacity for speech and are not expected to recover speech. The purpose of music therapy with such clients is to build a communicative relationship through music making. One therapist commented, *'Assessing the vocal interaction would seem more important than whether sounds or specific words are used*'. Indeed, overall the therapists showed greater interest in measuring changes in the frequency and duration of *non-verbal* singing; as a group they selected the comparison of instrumental activity to vocal activity more frequently than monitoring an increase in sung words. (From a technical point of view this is

positive because voice identification is technically challenging when therapist and client are singing together and moving between non-verbal and verbal sounds.)

It was important to look separately at the results of the therapists who identified themselves as future users of the program if it could help them gather objective data. These are the therapists who are most likely to use such a system in future. The most frequently chosen function selections of this group are indicated in *Figure 4.18*:

Figure 4.18: Survey 4; Question 1: Function Choices of Therapists Likely to Use Such a Program to Help Them Gather Objective Data.

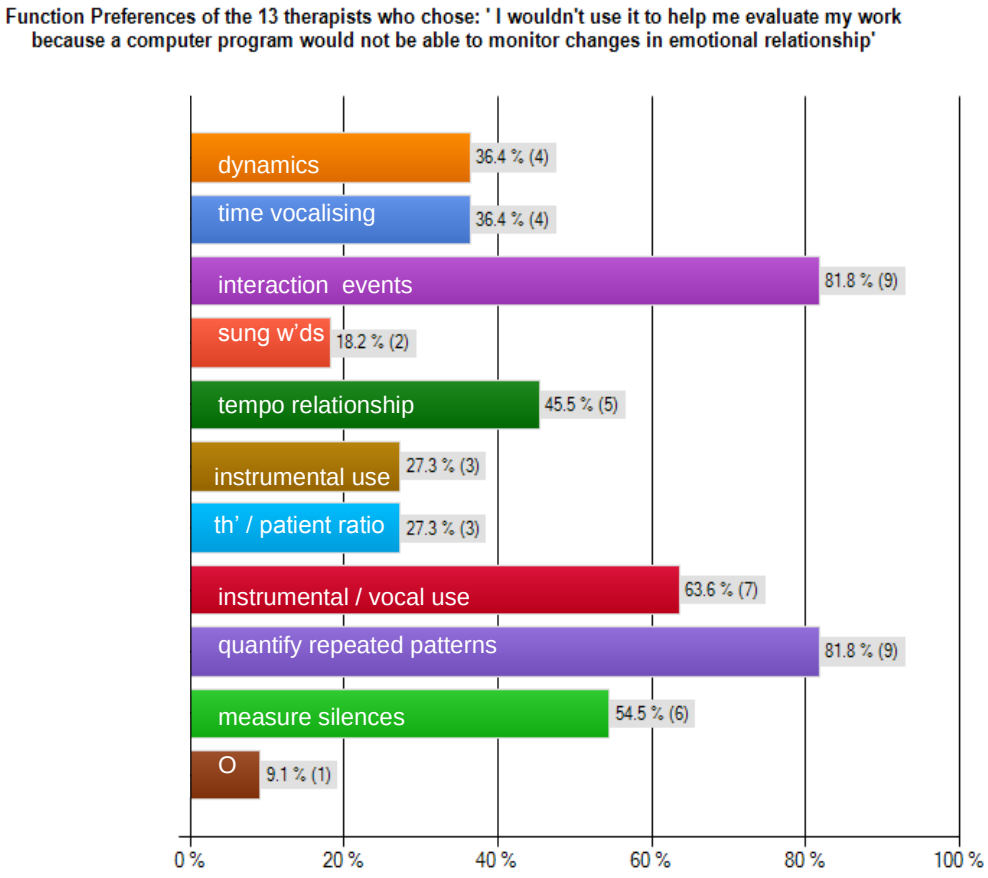


Number of therapists in subgroup who selected functions

It is therefore suggested that the top four selection choices illustrated above should guide any further development of the proposed tool. Perhaps these potential users want to be able to identify and quantify changes in a client's ability to be flexible rather than fixed, reciprocal rather than isolated in their musical communication with the therapist. In retrospect, it is regrettable that a question was not included asking the

therapists about the type of patients they were working with. One therapist commented: *'My answers are very specific to my current client group (adult mental health). If I were working with a different client group, e.g. autistic children, I might have ticked many more of the categories.'* This attitude may be reflected in the function choices of those therapists who identified themselves as very unlikely to use such a program in future. *Figure 4.19* shows that although unlikely to use the program, a large majority of this subgroup selected the top two functions to be included in the program.

Figure 4.19: Survey 4: Question 1 Results with Filter – Computers Cannot Monitor Changes in Emotional Relationship



Percentage of sub group (13 therapists) who selected functions

Suggestions offered for 'Other' analysis functions were grouped under seven themes: monitoring *other aspects of musical interaction* (other than imitation), monitoring *changes in the use of voice and speech*, monitoring how the *timing between therapist and client* changes, functions that would require the *integration of video* into the

system, functions that rely on the system being able to produce *musical notation*, the ability of the program to identify changes in *musical style*, and finally a function to monitor changes in the *tonal relationship* between the players (*Figure 4.20* lists summaries of all suggestions gathered.)

The focus on interaction gives further indication that being helped to objectively monitor a client's shared engagement in musical communication with the therapist is particularly desirable. Some suggestions (themed under 'Interact', *Figure 20*) were proven to be technically possible during this study, for example; 'Interaction' points 1, 2, 3, and 5. (The associated computational tests are presented in Chapter 6, of particular relevance are the results shown on pp.181-183).

Some of the therapists' suggestions imply the incorporation of video. It is important to value these suggestions. The prototype tested in this study was limited to audio analysis as the primary objective has been to investigate, devise and test analysis functions associated with music information retrieval at this stage.

Four therapists suggested functions that are technically impossible and these have not been included in *Figure 4.20*. One therapist wanted the program to measure *'...changes in the feelings evoked and exchanged, levels of distress at the start, mid-point and end of therapy.'* One respondent dismissed the analysis functions as too simplistic: '*The computer program would need to be able to measure far more than your few suggestions and assimilate different aspects together.'* another commented; 'It *seems too fragmented an approach to use. In reality many different things could be significant for any one client with great differences between clients'*

Two therapists worried that the program could start to determine the outcome of an evaluation. Rather than understanding the program as a tool under the control of the therapist, they felt the results could be misleading; *'Many clients use music to blot out or block relationship — so program chart could be very misleading, showing a high level of musical output without any measure of the content and dynamics of the music-therapeutic relationship.'* These attitudes were in the minority but they should not be dismissed. (18% of APMT members returned the survey; the opinions of the remaining 82% are unknown.)

Figure 4.20: Survey 4: Q.1: All 'Other' Analysis Suggestions

Interact	Voice	Timing	Video	Notate	Style	Pitch
1. Monitor initiation of sounds – is client able to start improvis-ations or do they follow, or wait? 2. Identify how frequently the client initiates and how much they follow. 3. Identify initiation of episode (and when therapist joins in) 4. Identify increase in cohesive playing between the client and therapist. 5. Measure time spent playing together, whether interactive or not. 6. Measure capacity to extend or vary a musical motif. 7. Measure interaction in terms of : similarity of material (pitch, rhythms, intervals, dynamics).	1. Map vocalis-ation in general so that it could include times when the client uses words. 2. Measure the relation-ship between musical and verbal communi-cation, and/or a quanti-tative measure of the correlation , if any, between the two. 3. Identify when talking takes place. 4. Time spent in non-musical verbal engage-ment.	1. Identify various forms of timing between therapist and client? 2. Length of time client stayed in the room and the frequency of returning within the session's length.	1. Monitor eye contact and proximity to the therapist. 2. Quantify increase in social interaction - e.g. eye contact, turn-taking. 3. Verbal interaction and play (role play and with toy figures) 4. The influence of other staff in the session 5. Measure changes in fine and gross movement 6. Identify change of quality (mainly listening ability) in the interactive episodes between therapist and client. 7. Measure the amount of times the client stopped the music therapist from playing or asked them to stop. 8. Measure amount of eye contact in terms of duration and changes.	1. Print out words used by the client in improvised songs	1. Measure changes in affective quality (i.e. rhythmic percussive playing and flowing melodic play 2. Measure client's capacity to vary/extend their musical motif 3. How did the style of music change, if any, over this period of time. (With PMLD clients, often we therapists can resort to repetition of style, which might be challenged, for the better.)	1. Measure proportion of client's vocalisation which relates to the tonality of the therapist's music 2. Some kind of pitch analysis that would indicate the client's degree of pitch organisation - to distinguish between genuine melody and speech contour. 3. Measure times when client's vocal or instrumental sounds match intonation wise with the therapist's, i.e. shared tonalities. 4. Identify the pitch range used by the client within an improvisation

Conclusion: Survey 4 Question 1.

The results indicate enthusiasm for the proposed analysis functions, particularly that which can monitor interaction events over time. 21% of respondents left suggestions; these were detailed, technically aware and relevant. 2 therapists worried that the tool could determine outcomes, another thought the analyses too simplistic.

4.6.4. Survey 4: Question 2

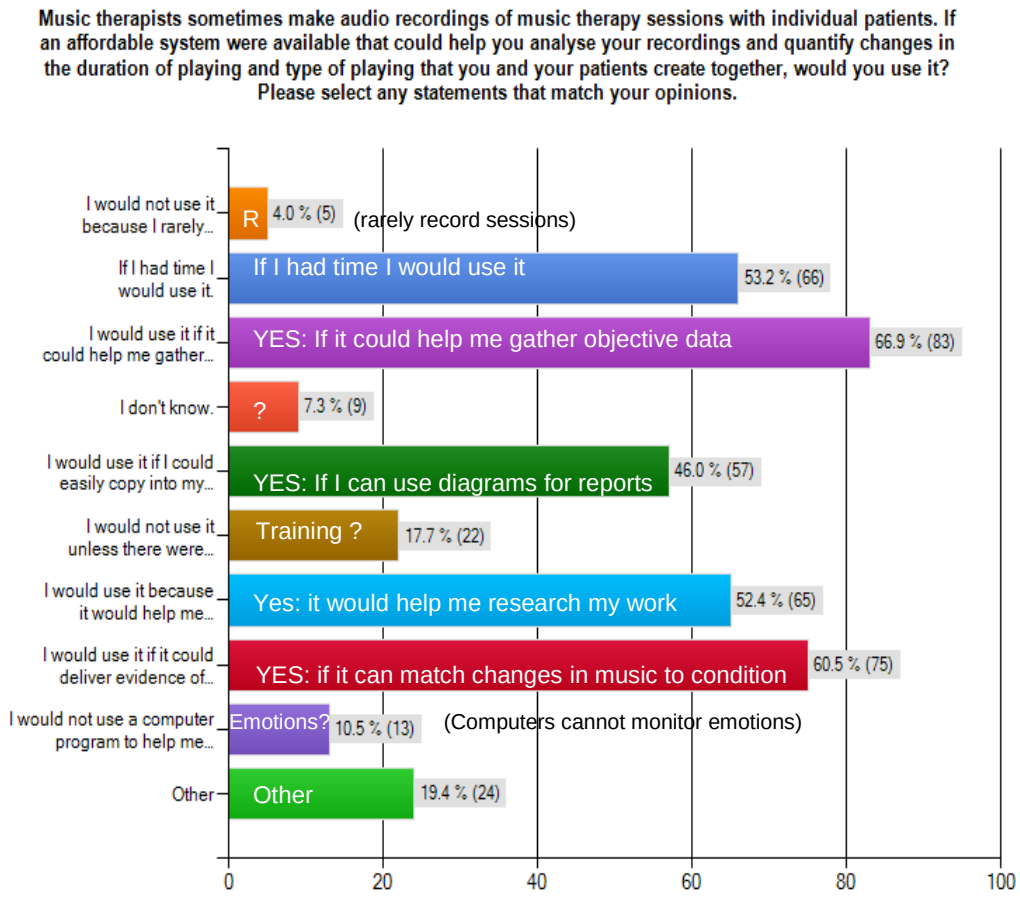
> *'If an affordable system were available that could help you analyse your (audio) recordings and quantify changes in the type of playing and duration of playing that you and your patients create together, would you use it? Please select any statements that match your opinions.'*

Based on feedback given by therapists who had responded to the previous surveys, the following answer choices aimed to further clarify the reasons why a music therapist might use, or might not use, a computational music analysis tool to help them evaluate their work. The answer choices were as follows:

1. *I would not use it because I rarely record my sessions.*
2. *If I had time I would use it.*
3. *I would use it if it could help me gather objective data.*
4. *I don't know.*
5. *I would use it if I could easily copy into my reports, diagrams illustrating a client's changing use of music over time.*
6. *I would not use it unless there were adequate training.*
7. *I would use it because it would help me research my work.*
8. *I would use it if it could deliver evidence of changes in the patient's music making that match to an improvement in the patient's condition, for example, a decrease in obsessional playing.*
9. *I would not use a computer program to help me evaluate my work because the program would not be able to monitor changes in emotional relationship.*
10. *Other*

Figure 4.21 illustrates the main results:

Figure 4.21: Survey 4: Question 2 Results: Would You Use It?

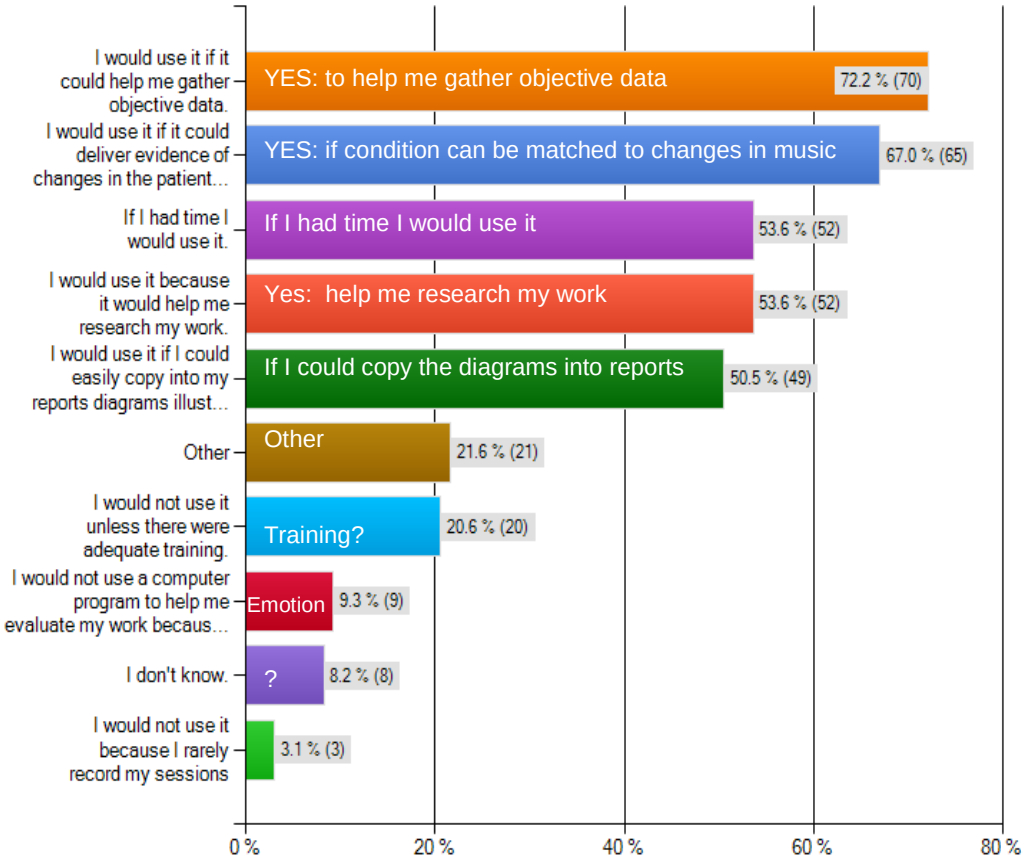


Importantly, the highest level of agreement was shown to match the main aim of the proposed Music Therapy Logbook system; that is, to help therapists gather objective data. It is significant that the third highest level of selection was *'If I had time I would use it'*. This reflects the concerns of the survey 3 respondents whose comments were discussed previously. Being able to use the system easily and being able to set up equipment quickly is emerging as a key factor to take into account in any future development of the tool. Based on the results of statement 3, the likelihood of using the tool in future was 67%

Further analysis of the results showed a higher level of response to potential use of the system from therapists who chose the interaction analysis function. *Figure 4.22* shows

that 72% of this group indicated they would use the system if it would help them gather objective data.

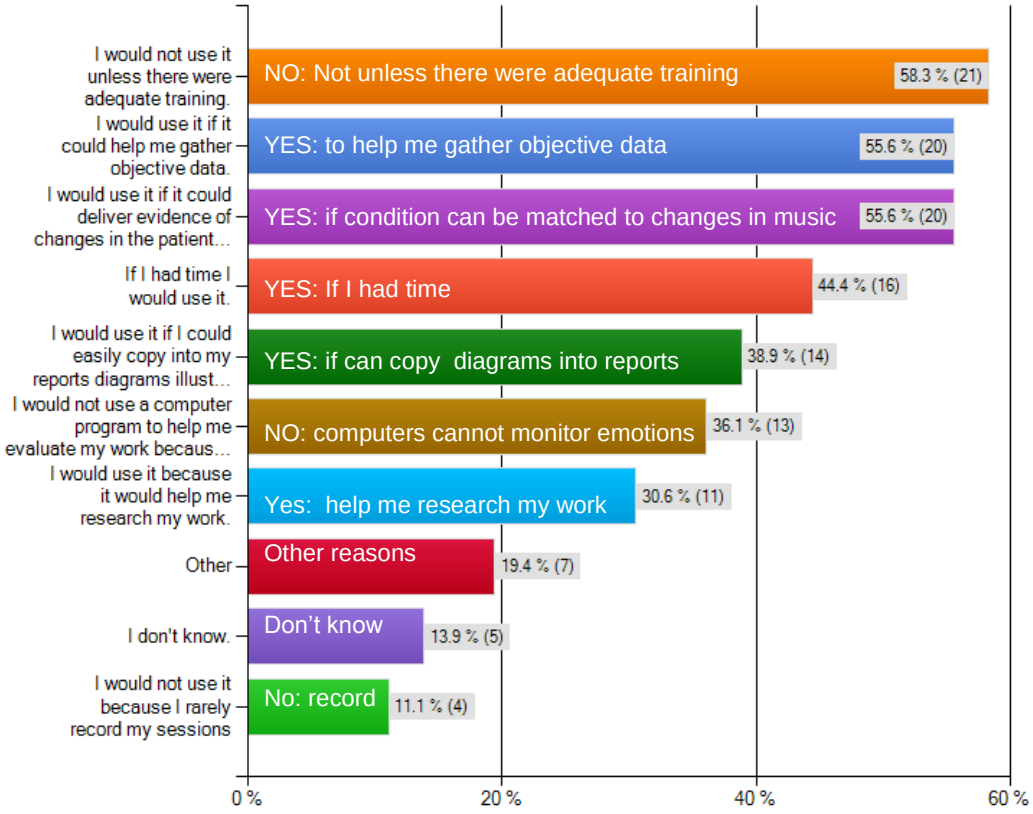
Figure 4.22: Survey 4: Question 2 - Preferred Reasons for Future Use of Those who Selected Interaction Analysis Function



A correlation of Q2 responses, from the 29 therapists who only selected *'I would use it'* type statements, showed their top four analysis function choices matched the top four choices of the whole group: identifying and monitoring interaction events, identifying and monitoring repetitive playing, monitoring non-verbal singing, and the ability of the software to produce a diagram mapping instrumental and vocal events over a number of sessions.

Figure 4.23 illustrates the statement choices of the group of therapists who selected any Question 2 statement beginning *'I would not use it'*. Their main concern appears to be whether or not therapists would have access to adequate training.

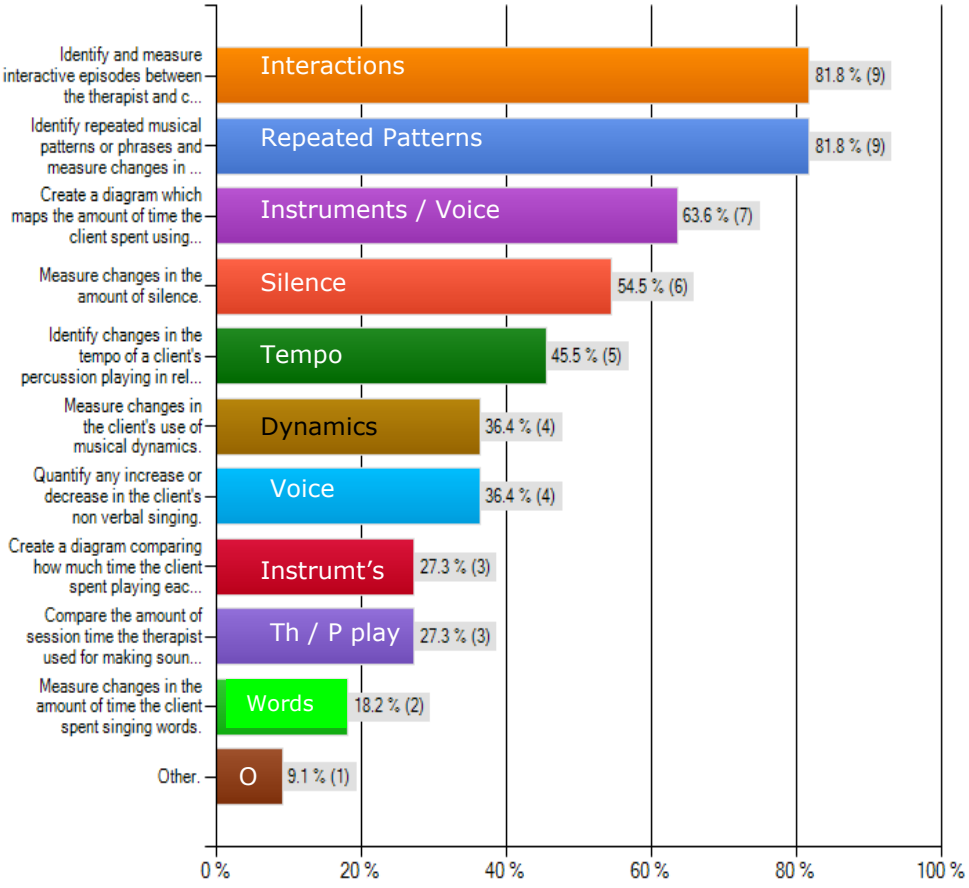
Figure 4.23: Survey 4: Question 2: Responses of Therapists who selected 'I would not use it' type Answers



Only one therapist chose all of the 'I would not use it' type answers. However, this therapist also selected three analysis functions he or she wanted to have included in the program: the interaction analysis function, identifying and monitoring repeated patterns or phrases, and monitoring changes in musical dynamics between the therapist and client. The therapist supplied additional comments under the two 'other' answer categories. Of her attitudes to using the computer program she supplied the following comment: *'My answers reflect my ambivalence. I would be curious to see it in action, but am not convinced that it would be able to detect enough of the nuances of therapeutic work.'* Thirteen percent (11 therapists) said they would not use it because a computer program cannot monitor emotional relationships. However, most of these therapists also selected analysis functions to be included in the software. Their preferences show a marked desire for monitoring interactions and measuring changes in patterning (very much in line with preferences chosen by therapists who

said they would use the program if it could help them gather objective data). *Figure 4.24* illustrates their analysis function choices:

Figure 4.24: Survey 4: Responses to Question 1 with Filter: 'I would not use it because it would be unable to monitor changes in emotional relationship'



4.6.5. Survey 4: 'Other' Comments: Question 2: Future Use

Nineteen percent of all respondents (24 therapists) gave reasons not listed for using or not using the system in future. Sixty percent of these comments described positive reasons for using the system in future (these are given in *Figure 4.25*), 35% of the comments expressed ambivalence and 4% indicated the therapists would not use the system. Comments offered by those likely to use the system in future were grouped under four themes: *identifying changes*, *evidence gathering*, *explaining music therapy,* amplifying changes in the *emotional /musical* relationship.

Figure 4.25: Survey 4:Q.2. Other Reasons for Future Use

Identifying Changes	Evidence Gathering	Explaining MTh	Emotional/Musical
1. I would try and use this in addition to our established analysis which charts objective observations (by school staff/parents and carers) of how a client's behaviour has changed outside the MT session (e.g. social, emotional, personal and learning skills) 2. I think this would be an extremely valuable tool for both clinical practice and research. The limits on my time are great, so anything that is easy to use and quick to demonstrate changes would be extremely useful!	1. It would help me to be more consistent about my recording of sessions (which is patchy, particularly in NHS settings). 2. Great if a computer can help with the hard data and I can add the non-quantifiable elements of the relationship myself. 3. I would consider using an additional program like this, as an adjunct to my song writing program. 4. A concrete means of showing aspects of musical relationship. 5. It would help me provide measured outcomes for quality of service and achievement for my clients. 6. It could support other more subjective methods of evaluation, rather than replace them.	1. Could be helpful in discussions with non music therapists in my work team. 2. It might be a selling-point in helping me to get colleagues from other professions to realise the importance and usefulness of recording sessions in the first place. 3. It would help me report to parents and referrers on changes in music therapy.	1. Changes in the emotional relationship can be captured by what is written, but may further be backed up by musical analysis. 2. Being able to accurately monitor musical/sound changes could reinforce the links being made by the therapist with regards the emotional relationship. 3. It would give clear musical evaluation that would illustrate the emotional / behavioural changes based on the assumption that behaviour is affected by our emotional state. 4. The use of such a program would be in conjunction with therapeutic processing of emotional content in the sessions.

Ambivalent comments, indicating that therapists were unsure whether or not they would use such a program in future, were grouped into the following themes:

- Ethical considerations
- Data made available would not capture depth of music therapy
- Could take time away from other more useful activities
- Concerns about user friendliness

One therapist commented, *'I think it would be very useful but the diagrams it produced would have to be easily interpreted by non-musicians, other professionals and ideally parents and family too. Simplicity is therefore key.'* another wrote, *'I would use it if it were simple to use'.*

One respondent commented: *'I honestly feel that the most important things that happen in music therapy cannot be analysed by a computer. However, in the current climate, I do believe it is also important to gather objective data as part of a broader evaluation process. Hopefully it would not be too complicated?!'* The concern here is that a computer program would iron out the complexities of music therapy and deliver explanations that miss the subtlety of the work.

This was further amplified by another respondent, *'These measures chart only musical behaviours in the music therapy process, probably of some use with clients with SLD or PMLD, developmental delay, or communication disorders, and no other emotional/psychological complications and certain adults with mental health conditions. But nothing to measure how communicative the musical interaction is.'* The assumption here is that the evaluation would be by automatic measurement of changes in musical behaviour and not subject to further interpretation by the therapist.

Once therapists understand that a specialist evaluation program is a tool to aid their existing methods (as the majority of therapists in this survey did), their fears perhaps will be alleviated, but the author's opinion is yet to be proven (and beyond the limits of this study.)

Of the two therapists (4% of the commentators) who left reasons for not using the program in future, the first concerned age and experience; *'At this stage of my career I would not train to use this, but I can see the value for a younger MT'.* The second therapist had ethical concerns due to the client group they were working with, *'At the moment I do not record sessions because the client group feel uncomfortable with this. I would want to use such a system, but question the ethics involved in making such recordings.'*

There was no request included in Survey 4 for gender identification. Therefore, attitudes that may have been influenced by gender, could not be analysed from Survey 4 and therefore could not be compared with those identified in Survey 3.

The top selected choice for not using the system was insufficient training; lack of confidence in using technology did not concern these respondents. It would seem the use of audio recording is highly prevalent amongst the respondents, as inability to record sessions was rarely reported. Therefore, if adequate training were given, it is likely that more respondents than not would use the system in future.

4.6.6. Summary of Survey 4 Question 2 Results

Overall, the likelihood of these UK respondents (N=125) using a computational music therapy analysis program for analysing audio recordings of their work (using the type of music analysis functions described) was 70% (if the tool can help them gather objective evidence).

4.7. Chapter 4 Conclusion

By completing four surveys it has been possible to gather opinions from a range of potential users of the proposed Music Therapy Logbook system. 185 music therapists responded in all. Their opinions helped to inform the technical tests carried out later in this study. Enthusiasm was expressed by the majority of music therapists for a 21st-century tool that can enhance the predominantly subjective methods they currently use for evaluating their therapy work. The mean score for the likelihood of potential

future use is 73%. This result is based on the combined mean scores of 3 surveys (Survey 2, N=10; 77%), (Survey 3, N=44, 74%) (Survey 4, N=125, 67%). It should be noted that Survey 4 was short, did not describe the proposed evaluation system and asked only two questions which both concerned analysis of audio recordings by a computer program. Surveys 2 and 3 were very much more detailed and gave a greater level of description of the proposed tool.

A number of key issues emerged from the user opinion research. First, the advisability of tailoring analysis functions in relation to specific patient populations. It became clear when comparing the results of Survey 3 with those of Survey 4 that therapists' preferences for analysis functions differ when they are given a specific clinical context to take into account. (Surveys 2 and 3 gathered information only from therapists working in the neuro-disability field). Therefore, the next phase of development work would be best approached by determining the analysis functions necessary for monitoring work with other patient groups, for example children on the autistic spectrum as compared with adults with depression.

The second issue arising is the desirability (or not) of including video analysis. It is clear from the results of Surveys 2, 3 and 4 that therapists record video signals as frequently, if not more frequently, than they record audio signals. Some suggestions offered by Survey 4 respondents would require video analysis if implemented. Although those who offered video related comments were in the minority, their views need to be taken into account in the next phase of the development work.

Third, is the need for the system to be easy to learn, easy to use and quick to set up. Of course anyone using software wants it to be easy to use, but for a specialist system to be useable by music therapists ease of use is essential; music therapists are under time pressure with timetables that already often deter regular session evaluation. One therapist commented, *'I think it could be really valuable. It would be very helpful if it was 'user friendly' and there was a simple training guide included in the package, so that I could trouble-shoot problems easily. I would be much more likely to use it under these conditions.'*

Few therapists were concerned that the software is not being developed to monitor changes in emotional relationship. One therapist commented; *'If a computer can save us time by charting such things, it is up to us to consider their meaning (if any) within each therapeutic relationship.'* Others rightly drew attention to the need for robust ethical considerations, such as confidentiality and long term storage of patient related data.

Attitudes to future use may be affected by gender, but it was not possible to ascertain the certainty of this. Some results seemed to suggest that women users may be more cautious about the possible benefits in relation to the practicalities of their work settings. The results of Survey 2 suggest that part time workers may have different attitudes to full time workers.

The results of the largest survey, Survey 4, (N=125) point towards the likelihood of four key analysis functions meeting user needs. Therapists selected these as their top preference functions from 10 possible choices.

- Detecting and measuring changes in musical interaction episodes
- Detecting and measuring changes in repetitive musical patterning
- Detecting and measuring changes in non-verbal vocalization
- Mapping changes in instrumental use and vocal activity over time

Although the Survey 4 score for therapists using a computer program to gather evidence from audio recordings was 67%, 91% of Survey 4 respondents selected *measuring changes in musical interaction* as a function they wanted included in a computer program to help them evaluate their work. There would therefore seem to be a gap between what therapists want and what they are likely to use.

As the program was not described to these respondents in any detail, this may partially explain the difference, however, it may also reflect the data analysis of all four surveys which suggests that more music therapy sessions are recorded than are ever reviewed (using either audio or video playback). Lack of time is likely to be one of key issues affecting review.

The preferred computational analysis choices of the therapists in Survey 4 relate to the distinctive nature of music therapy, as distinct from other types of intervention such as psychotherapy or occupational therapy. They also match to one of the main purposes of the proposed system – to help music therapists gather evidence of changes in a patient's and therapist's use of music over time.

Amplifying the link between emotional changes and musical changes was not considered possible for the system at this time, however, some music therapists unexpectedly considered the functions described in Survey 4 as potentially helpful to them in this respect. One commented, *'It would give clear musical evaluation that would illustrate the emotional/behavioural changes, based on the assumption that behaviour is affected by our emotional state.'*

Being able to monitor the therapist's music as well as the client's was also thought to be beneficial: '*Being able to analyse our work in this amount of detail will not only benefit the clients, as we make better informed decisions regarding goals and objectives and assessments, it will also benefit us. We will become aware of changes or improvements we need to make.'*

CHAPTER 5: What is Possible? Technical Feasibility

5.1. Introduction

The proposed Music Therapy Logbook system has two core functions: audio signal acquisition and audio analysis. The purpose of this chapter is to outline each of the technologies involved in delivering those two main functions, then to discuss the feasibility issues arising. (During the course of this study signal acquisition and audio analysis were tested in laboratory and clinical settings. The tests and test results are presented in Chapter 6.)

The two main functions of the system rely on the following processes; audio recording, audio data storage, sound recognition, music information retrieval, performer identification, and software interface design. As the author is a music therapist, rather than an engineer, general feasibility issues (rather than technical details) pertaining to these processes, are discussed in terms of their relevance to the music therapy evaluation tool under investigation.

5.2. Overview of Audio Recording Method

Although it is not the purpose of this study to give detailed specifications on technical issues related to sound recording technology, microphone technology or digital processing, it is important to describe the type of expected recording system to be implemented and to discuss the feasibility issues arising.

Based on what is possible now, it is proposed that a multi-channel, wireless, digital audio recording system will be used with small contact microphones, linked to small radio transmitters. The microphones (with their individual transmitters) are to be attached to the instruments in the music therapy room in such a way as they do not encumber the client playing the instrument, or distract them from playing an

instrument. For example, a small microphone can be attached to a snare drum frame close to the drum head. *Figure 5.1* shows such a microphone attached to a snare drum frame; in turn the microphone is linked to a small radio transmitter. *Figure 5.2* shows a transmitter attached to the drum's stand with a lead winding upwards towards the microphone.

Figure 5.1: Microphone attached to drum frame

Figure 5.2: Transmitter attached to drum stand

The microphones record audio signals from each independent instrument and these signals are then transmitted direct to a multi-channel receiver device linked to a small laptop computer. This, in turn, runs the recording software. Therefore, the music therapist and patient can move the instruments and walk around the instruments without stepping over microphone leads or wires.

Although it would be possible for each contact microphone to be noise gated, (meaning that the level of sound captured from other sources would be limited), noise gating is not considered advisable because the technique is designed to cut out all sound of acoustic levels below a pre-set threshold, including low levels generated by the instrument being recorded. The proximity of the microphone to the sound source remains the most important factor in ensuring a high degree of audio separation on

each of the instrumental tracks for purposes of later computer analysis. However, levels of audio separation vary according to which instrument is being recorded, and the level set for each microphone input.

There are technical issues to resolve regarding the switching mechanism for the microphones as it will be important that they are not accidentally switched off when the instruments are played. In future, it is hoped that some of the settings in which music therapists work (such as training or research centres) could be equipped with instruments that have been specially designed to contain the necessary contact microphone/transmitter equipment. For example, specialist musical instrument makers, such as the German company, Bernard Deutz Klangwerkstatt, (2010) could be approached for future collaboration on such a project. *Figures 5.3* and *5.4* show examples of the specialist music therapy instruments they already market to music therapists.

Figure 5.3: The Klangstuhl

(www.deutz-klangwerkstatt.de/klangstuhl.pdf.p.2.)

Figure 5.4: The Kleine Leier

(www.deutz-klangwerkstatt.de/freiesspiel.pdf, p.1)

Notwithstanding the future possibilities of such collaborations, the aim in this study has been to investigate the use of readily available recording equipment for the purposes of proving the concept of the Music Therapy Logbook system.

5.3. Receiving Audio Signals and Storing Audio Data

Using this recording method, the transmitters for each of the instruments send signals to a small, portable multi-channel audio signal receiver device; this can be located away from the activity area of the therapy room. The session is recorded straight to a laptop, the radio signal receiver is placed nearby. *Figure 5.5* shows a test session. Here the laptop sits on top of a box containing the radio signal receiver.

Figure 5.5: Lab Test 1.University of York

The advantage of recording straight to a laptop is that audio files are automatically stored where they can easily be accessed. However, there are two possible disadvantages; first, there is the risk of losing data, due to the laptop crashing during recording, second, the computer may have to be shared by a number of music therapists (if used in an arts therapy department) and this raises the possibility that it may not always be available for recording music therapy sessions when required.

An alternative method, would be to record direct to a dedicated solid state multi-channel recorder, specifically engineered for the purpose of audio recording. Systems exist whereby you can later exchange files from such a recorder to a computer for later analysis. *Figure 5.6* illustrates an eight channel recorder produced by the Japanese company Zoom. This device can record either directly to a solid state drive or act as an interface for recording direct to a laptop via USB, if preferred. (The cost is approximately £300). Such devices illustrate the fact that appropriate and affordable

technology has already been devised which is capable of simultaneous recording of eight separate channels.

Figure 5.6: Zoom R16, 8 Channel Multi-Track Recorder

www.zoom.co.jp/english/products/r16/360view.html

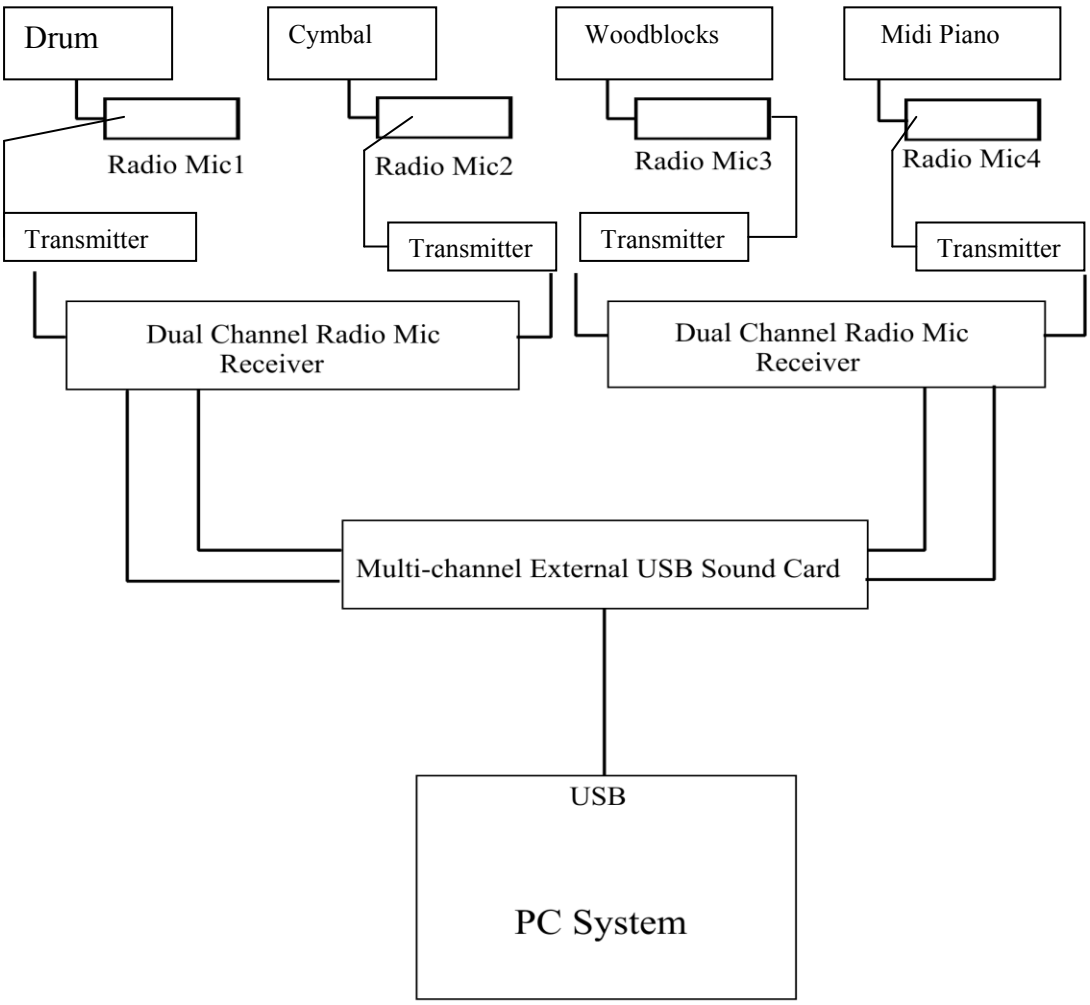
This particular recorder has the ability to generate a synchronization signal (based on USB data transfer timing.) Therefore by connecting two R16 units via USB, you can designate one to function as a USB host and the other as a USB slave, allowing synchronized recording on 16 tracks simultaneously. (It is unlikely that a music therapist would use more than eight instruments in an individual music therapy session)

5.4. Recording System Used for Tests

Figure 5.7 sets out a diagram of the recording system used in this study for the purpose of acquiring and storing test recordings. The tests were recorded direct to a full size PC laptop, but it is expected that one of the smaller type of laptop computers would be more appropriate (if that is the preferred recording device). Mini-sized laptops are becoming increasingly available and increasingly powerful. The test system (described in detail in Chapter 6) recorded onto four separate channels, but it is intended that a fully resolved system would have the capacity to record onto eight channels or more. A set of 9 graded improvisations was recorded to test the system. (The audio files are contained in *Media Example 1*. N.B: it is suggested the reader

waits to listen to these in the context of Chapter 6, *Figure 6.14*, where computational analysis maps can be used to examine the files.)

Figure 5.7: Diagram of Multi-channel Wireless Digital Audio Recording System



Whichever system is used, whether recording direct to a laptop or onto a dedicated recording machine, when it is not appropriate to record sessions the sessions would not be recorded but the tiny contact microphones could remain in place, attached to their instruments, switched off.

Even if the microphone/transmitters were accidentally left switched on, neither the receivers nor the recording software would be in use and therefore no sound would be recorded.

5.5. Overview of Music Technology Tools

Before discussing the computational analysis of music therapy recordings, it is helpful to clarify the broad range of available music technology tools. The tools fall into five main groups: *electronic musical instruments*, such as synthesizers and MIDI keyboards, *notation software*; for example, MIDI linked packages such as Sibelius. *(*www.sibelius.com*), creative production tools*; e.g. digital audio workstations, such as ProTools (www.avid.com/US/products/family/pro-tools), *music composition tools*; for example, the visual programming language Pure Data (Pd) (www.puredata.info*),* and *music information retrieval software;* designed to extract information from audio recordings, for example, Intelliscore (www.intelliscore.net/*).*

The computing technology field is accelerating fast as computer programmers solve new problems and new computing goals are set. Similarly, engineering technology is accelerating. These are highly innovative and competitive fields with a particular emphasis at the moment on convergence – the ability of functions to be shared between devices. Consumers are probably most familiar with convergent technologies when using mobile phones to take photographs. Increasingly, manufacturers are attempting to combine functions within the same device. For example, the multi-touch-sensitive media player and application running device, Apple iPad, (www.apple.com/ipad/features/) allows the user to switch from viewing photographs, reading i-books, sending email and viewing videos.

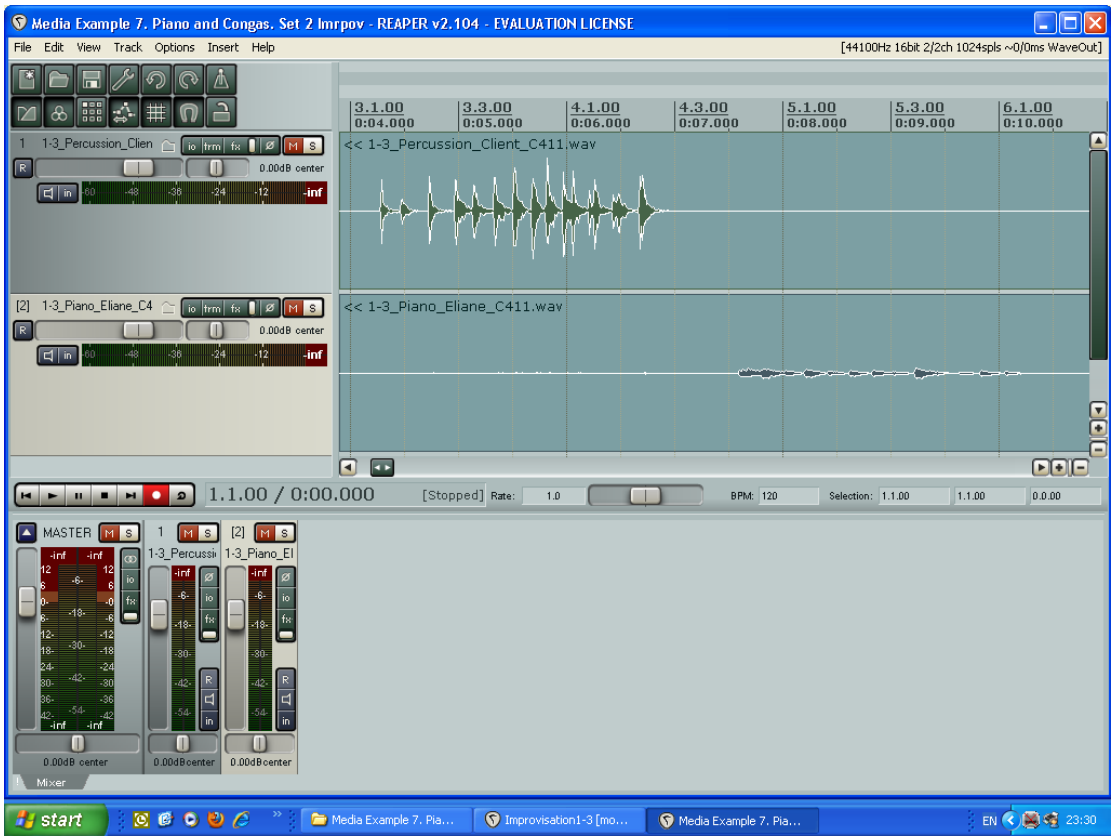
In the music production field such systems as ProTools (www.avid.com) encourage the user to compose music, record, mix and edit using a family of compatible hardware and software components. Computer processing speeds have advanced rapidly over the last ten years. Such production tools have therefore increased their efficiency with regard to storing digital audio data, allowing sophisticated graphic representation of sound waves and facilitating the editing and analysis of multiple audio tracks from those graphic representations linked to audio playback. Therefore,

the concept of combining a number of different functions into one system that can be used for different, yet related, purposes, is already very well established.

Figure 5.8 shows a screen shot of the Reaper (http://www.reaper.fm/) sound editing program. The program is playing two tracks from a multi-track test recording undertaken for this study; the top track shows the recorded drum, the lower track shows the acoustic piano track. (It may be interesting to note at this point that there is no audio spill on either track, so that when the drum plays it does not register on the piano track and vice versa).

Tools for editing can be seen on the top left hand corner of the page. Audio files can be inserted, edited, copied and stored using such programs.

Figure 5.8: Reaper v2.104 Audio Editing Program in Action



(http://www.reaper.fm/)

5.6. Audio Separation

Bearing in mind the purpose of the recording system, maintaining a degree of audio separation is important. Such creative production tools as that described above, do not in themselves deliver distinctions between specific sound sources, other than via their ability to play a number of audio tracks separately. In principle, distinctions in sound are pre-created by careful multi-track sound recording so that different sound sources are collected and stored on separate audio tracks. Given the fact that a microphone cannot distinguish between desired sound and undesired sound, the efficiency of audio separation of a multi-track system relates to the quality and function of each microphone used, and the placement and shielding of each microphone.

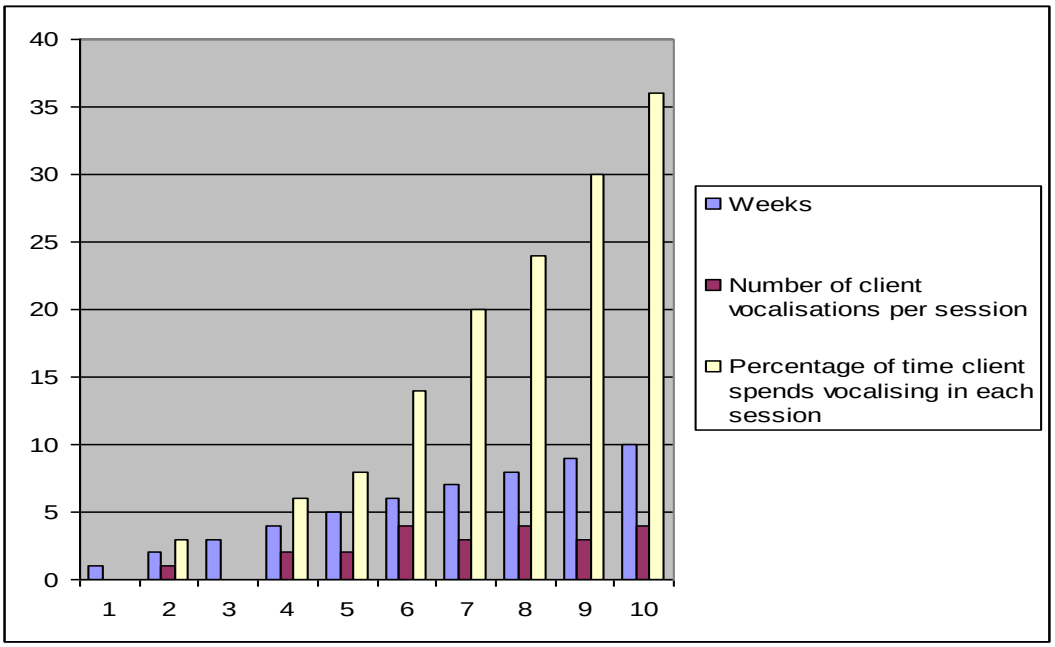
However, sound separation is initially only as accurate as the sound recording that has preceded it. Unlike a film sound track which can be altered by re-recording dialogue and mixing in sound effects after the initial recording session, a music therapy recording is a one-off event which cannot be re-recorded and, if used for the purposes of treatment evaluation, must not be altered.

Given an appropriate level of audio separation achieved from each of the audio tracks, it is very likely that, following a further period of research and development, the Music Therapy Logbook system can incorporate a number of automatic music analysis functions, for example automatic measurement of the duration of play on a particular percussion instrument. The data analysis could then be represented by a chart, such as that illustrated in *Figure 5.9.*

The example chart shows that, if the computer were able to detect an increase in the number of times a client vocalised, and that from session 6 onwards this increase were largely maintained, the duration of each of the vocalisation episodes would be quantifiable and easily understood by non music therapists working in a multi-disciplinary team.

The example chart indicates how a marked increase in the duration of vocalisation episodes across a number of weekly sessions could, in principle, be represented:

Figure 5.9: Example chart designed to represent increase in a client's vocalisations



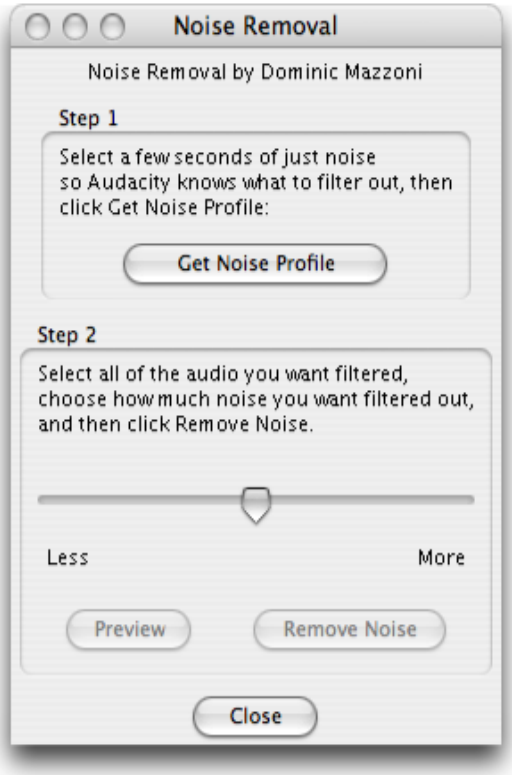
Even at the most basic level of analysis, for example quantifying the amount of sound occurring in any one session in relation to many other sessions, the user opinion research has shown it is likely to be useful for music therapists to gain access to this type of data. Calculations of how much playing took place in one session, as compared to many other sessions with the same client, would take hours, possibly days to undertake with ears only, so these types of calculations are rarely attempted.

5.7. Sound Recognition

There are two approaches to sound recognition which are relevant to the proposed system. First is the *knowing about the sound and subtracting it* approach, second is the *knowing about the sound and recognising it* approach. Both approaches are technically proven outside of the music therapy field. For example, noise reduction techniques (the subtraction of unwanted sound) are used to attenuate background noise, such as electronic hums accidentally recorded from equipment. These techniques are employed by editing programs, for example 'Audacity' (http://audacity.sourceforge.net/). Using the noise reduction feature the user selects

an unwanted noise from an audio track, the software then ‘learns’ the sound and is able to recognise and subtract that sound from a selected passage of the recording.

Figure 5.10: Audacity Noise Removal Function



(http://audacity.sourceforge.net/about/images/effect-noise-removal.png)

In principle then, it is possible for a computer program to recognise a sound, identify when it occurs and subtract it from an audio recording.

The second approach is used, for example, by sound recognition programs that convert speech to text (to help those who cannot type, or do not wish to type, be able to write text.) Speech recognition software is used as a replacement for typing on a keyboard; for example, Dragon NaturallySpeaking (2010) allows users to speak into a head set whilst the computer transcribes the spoken word .Once the software has learned to recognise the speech of the user, it can recognise the user’s speech from a voice recording and create a document using the transcribed sounds.

It is therefore suggested that these two approaches may, at least in principle, provide starting points for approaching solutions to two problems yet to be resolved concerning the proposed music therapy evaluation system.

The first problem is how software can be programmed to filter out sounds that are extraneous to the music therapy session, for example the sound of a door slamming in an outside corridor is easily mistaken for a drum beat by a computer. The second problem is how to distinguish voices from instrumental sounds when they are sung and played together, and how to distinguish one voice from another when they are sounding separately. (To distinguish one voice from another when therapist and patient are both singing is likely to prove extremely difficult, if not impossible.)

However, if voice recognition and sound subtraction techniques can be adapted and incorporated into new software, (designed for the purpose of evaluating music therapy session recordings), then a music therapist could use the recording system to make separate sample recordings of each of their instruments, played individually in the new music therapy room. They would also make sample recordings of the background atmosphere of the room, their own speaking and singing voice in the room, and any extraneous sounds that are likely to take place, such as the sound of the door of the music therapy room opening and closing, and any recurrent external sounds. This sample data would then be stored as a contextual sound file so that audio analysis software can be helped to detect and subtract, or merely detect, when these sounds occur in recordings made in the music therapy room. Pre-recording the music therapist's vocal range and speaking voice may help the software identify the therapist's voice from that of the client.

Expert music information retrieval researcher, Dr Matthew Davies (Queen Mary London University) has advised that, under laboratory conditions, it is likely that the approaches described above could be successfully applied, but that in real life music therapy situations, if vocalisations from the two players overlap in frequency, it would be difficult for a computer to distinguish between the voice of the therapist and that of the client using voice recognition alone.

5.8. Performer Identification

The Music Therapy Logbook system is proposed as appropriate for recording music therapy sessions in which one therapist and one client are playing acoustic music together, sometimes changing acoustic percussion instruments during the course of a song or improvisation. In addition, MIDI instruments may be played.

If automatic computational analysis is chosen, rather than semi-automatic analysis, a performer identification system will be necessary in order that an instrumental audio signal can be identified with a particular player. Such a system is likely to make use of either infra red technology or RFID (radio frequency identification device) technology. Systems that use such technology include product coding in supermarkets where a product is recognised at the cash till by an RFID tag and also in medical settings (Fisher, 2008).

Future investigations will determine which type of technology is best suited for this purpose. Due to the noise reduction and sampling techniques which are available (discussed earlier) it is proposed that only one player need wear an identifier.
The therapist is best suited to wearing an identifier (as in many cases, inviting a patient to wear an identifier would interfere with the therapeutic relationship and introduce an element of performance into the therapy session). The identification technology could be integrated into a soft music badge worn on the therapist's lapel, or into a wrist band worn around the wrist. However, the type of technology used has implications for the design of the final transmitter. In the finished system the radio transmitter would incorporate performer identification receiver technology that could recognise, say, the therapist's RFID signal and match it to the audio signal being transmitted from the instrument he or she is playing; when the therapist played an instrument the audio signal transmitted would be associated with the necessary information. Further research and development of the signal transmitter and receiver component design of the proposed system are necessary in order to determine the most appropriate engineering resolution. In any event the technology would be contained within a safe, comfortable object for the therapist to wear. (N.B: Semi-automatic analysis may be preferable; in this approach the therapist identifies the player of each instrument after the session has been recorded.)

Signal Analysis

Because digital audio information is processed as numbers (e.g., a CD disk stores 44,100 samples per second for each track of audio with a 16 bit resolution) quantitative computer analysis of separated audio data streams is possible because the audio signals stored from each music therapy session will automatically be stored as numbers. Therefore it is proposed that mathematical analyses can be generated by a computer to deliver analysis of changes in a patient's and therapist's use of music over time.

5.9. Music Information Retrieval (MIR) Overview

As the author is a music therapist rather than an engineer, this study has mainly focussed on the question, 'What should be quantified?' rather than 'How can data be quantified? Therefore in this section the author provides a general overview of the music information retrieval field and discusses key issues arising that are likely to influence the future technological specification of Music Therapy Logbook music therapy analysis software.

Music information retrieval is the intended capacity of a computer program to:

- recognise musical events (either from MIDI generated audio files or from digital audio files recorded from acoustic instruments)
- match those events with other stored musical information
- match all events to a user's question.

It was assumed for the purposes of this study, in which a prototype music therapy evaluation system was tested (when both acoustic and MIDI instruments had been recorded), that music retrieval techniques for extracting musical data from non MIDI audio files would need to be investigated.

Research and development of algorithms to identify, match or extract music data have historically developed from the following general areas of investigation: models of tonality (e.g. Krumhansl, 1990), time feature recognition, for example beat and meter recognition (e.g. Johnson-Laird, et al., 1991), methods of representing music (e.g. Dannenberg, 1993), pitch and key identification (e.g. Shmulevich, et al., 2000, Chew, 2002), chord recognition (e.g. Tee, et al., 2002), identification of melodic structures (e.g. Thom, 2002), and style recognition, including pattern recognition (e.g. Whitman, at al., 2002).

The aim of much music information retrieval research is to build appropriate algorithms to identify and retrieve musical data from acoustic audio recordings, with or without first converting the audio file into a MIDI file. Regarding progress in this area there is noticeable divergence in the literature between the results of academic research into music information retrieval and the technological claims made by commercially available programs.

Typically, commercially available systems, such as Intelliscore Ensemble (http://www.intelliscore.net/), convert audio files (CD, WAV, MP3, WMA) comprised of several different instruments to multiple MIDI files. For example, Digital Ear (http://www.digital-ear.com/digital-ear/index.asp) converts solo instrumental audio tracks to independent MIDI files which can then be scored, notated or parsed for information so, for example, a melody that is first sung into a microphone can be heard back on a sequenced violin. Over the last five years such systems have attempted to move beyond mere solo instrumental recognition to polyphonic recognition.

Music information retrieval (MIR) was at first expected to work on the same basis as information retrieval (IR). Information retrieval is a technique of data matching between separated words. It remains the matching power house of internet search engines such as Google which rely on retrieving words and matching them to a user's input. However, identifying and matching musical data is far more complex than simple word matching. The aim of much of this research is eventually to be able to retrieve and represent complex polyphonic music, such as orchestral symphonic material and thus be able to create bibliographies and make comparisons between

different performances of the same pieces of music. By 2002 it was generally agreed that this type of intelligent retrieval is many years down the line. In their paper, **'**Problems of Music Information Retrieval in the Real World', delivered at the 6th International Conference on Music Information Retrieval, (Byrd & Crawford, 2002) the authors noted that,

> Although a substantial number of research projects have addressed music information retrieval over the past three decades, the field is still very immature. Few of these projects involve complex (polyphonic) music; (Byrd & Crawford, 2002. p.249)

They went on to outline the difficulties inherent in recognising a musical phrase within polyphonic music and how this differs from word retrieval;

> The fact, long recognized in projects involving monophonic music, that a recognizable passage is usually not identical with the search pattern means that approximate matching is almost always necessary, yet this too is severely complicated by the demands of polyphonic music. Almost all text-IR methods rely on identifying approximate units of meaning, that is, words. A fundamental problem in music IR is that locating such units is extremely difficult, perhaps impossible.
>
> (Byrd & Crawford, 2002. p.249)

5.10. Key Areas of Music Information Research

The key areas researchers are attempting to resolve that have important consequences for the future computing capacities of the Music Therapy Logbook system are:

- Recognition of the human voice
- Separation of polyphonic vocal recordings
- Recognition of drum and percussion rhythms
- Multiple pitch recognition
- Melodic matching
- Pattern recognition
- Key recognition

These areas of investigation seem to amply parallel the continuing interests of music therapists. Music therapists frequently concern themselves about these questions:

- Who played what instrument, when and for how long?
- Who sang or made a vocal sound in relation to whom for how long?
- Whose idea was it to play or sing in that key?
- Was I able to correctly match someone else's tempo?
- Was I able to recognise an event as a 'pattern' between us?

This would seem to indicate that the field of music information retrieval and the concerns of music therapists are closely related. For example, *Figure 5.11* outlines titles of papers given at the 2006 International Conference on Music Information Retrieval. From these research topics it can be seen that one of the main technical challenges at that time was to program a computer to recognise different types of instrumental or vocal sound, and distinguish between sounds that are happening at the same time sufficiently distinctly for a notation system to accurately represent them.

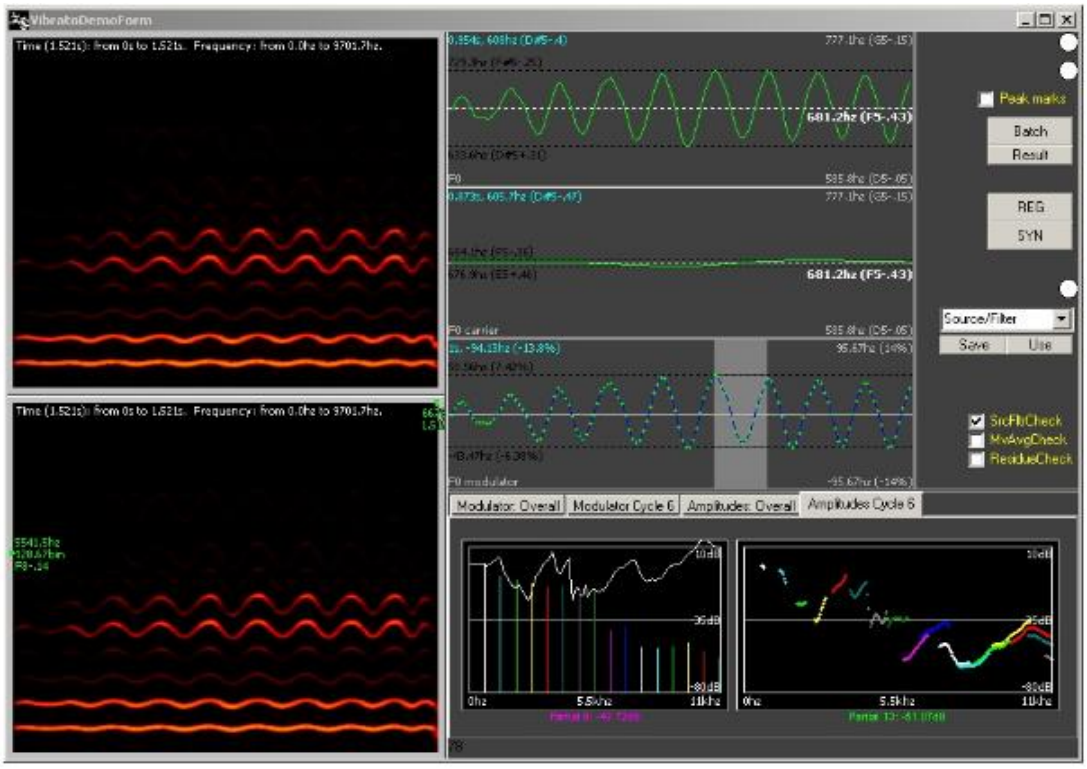
Figure 5.11: Examples of papers from the 7th International Conference on Music Information Retrieval, 2006.

Title	Authors
Transcription of the Singing Melody in Polyphonic Music	Matti Ryynänen and Anssi Klapuri
Music Information Retrieval from a Singing Voice Based on Verification of Recognized Hypotheses	Motoyuki Suzuki, Toru Hosoya, Akinori Ito and Shozo Makino
Improving Beat-Tracking by Stream-Based Evaluation of Musical Events	Frank Seifert, Katharina Rasch and Michael Rentzsch
Independent Component Analysis for Music Similarity Computation	Tim Pohle, Markus Schedl, Peter Knees and Gerhard Widmer
A Pattern Recognition Approach for Melody Track Selection in MIDI Files	David Rizo, Pedro J. Ponce de León, Antonio Pertusa, Carlos Pérez-Sancho and José M. Iñesta
The Significance of the Non-Harmonic "Noise" Versus the Harmonic Series for Musical Instrument Recognition	Arie Livshin and Xavier Rodet
Singing Voice Separation from Monaural Recordings	Yipeng Li and DeLiang Wang

Current Music Information Retrieval Research

To check whether these areas of interest are still active or have indeed been superseded, the author undertook an informal survey of ongoing research projects at the Centre for Digital Music, Queen Mary University of London, a leading international research centre for music information retrieval. It was found to be the case that much of the current research into music information retrieval is still generated by the desire for automatic music analysis (and therefore possible graphical notation) of historical recordings. A major project is the Omras 2 project (http://www.omras2.org/) which is investigating methods of annotating and searching collections of both recorded music and digital score representations. A spin-off of the research has been the development of the Harmonic Visualiser program .This functions as an audio editing program that can retrieve individual notes from polyphonic as well as monophonic audio recordings (Mauch, et al., in press, Mauch, 2010, Fazecas, et al., 2009). *Figure 5.12* shows a screen shot of the program.

Figure 5.12: Harmonic Visualiser Audio Editing Program



(http://www.omras2.org/HarmonicVisualiser).

Harmonic Visualiser is designed to retrieve data from noisy recordings and from polyphonic audio mixtures, independent of whether or not the notes on the original recording were harmonically correct. Although the main purpose of this program is automatic analysis of historical musical recordings, the engineering driving the technology is likely to be relevant to the proposed Music Therapy Logbook system: for if it is now possible to retrieve such information from 'dirty' recordings, then the computing technology is likely to be applicable to mono tracks with a certain amount of audio signal spill.

Individual researchers at the Centre for Digital Music were given a brief questionnaire and asked to summarise their ongoing research topics. (As much of this research is ongoing and has not yet been published, the author has referred to each researcher's name in respect of their ongoing research. For further information on these projects please refer to the Centre's website (*http://www.elec.qmul.ac.uk/digitalmusic/*).

Adam Stark was investigating a tool for identifying a repeated musical sequence and predicting its occurrence in a piece of music. The sequence prediction tool is not being developed to identify segments as a whole, but will be capable of identifying repeated sub-sequences and then inferring what the likely future elements of the music will be, based upon the past.

Andrew Nesbitt was researching audio source separation, i.e., processing a mixture of audio signals to extract or estimate the constituent sources. The tool is being designed to separate out each musical instrument from a CD recording.

Dan Stowell was working on timbre remapping via beat boxing. (Beat boxing is a creative musical performance using the voice as a percussion instrument.) The research topic involves developing real-time voice timbre analysis and translation for controlling a synthesiser via beat boxing. In this program the vocal signal is sent to a synthesiser which then orchestrates the vocal sounds.

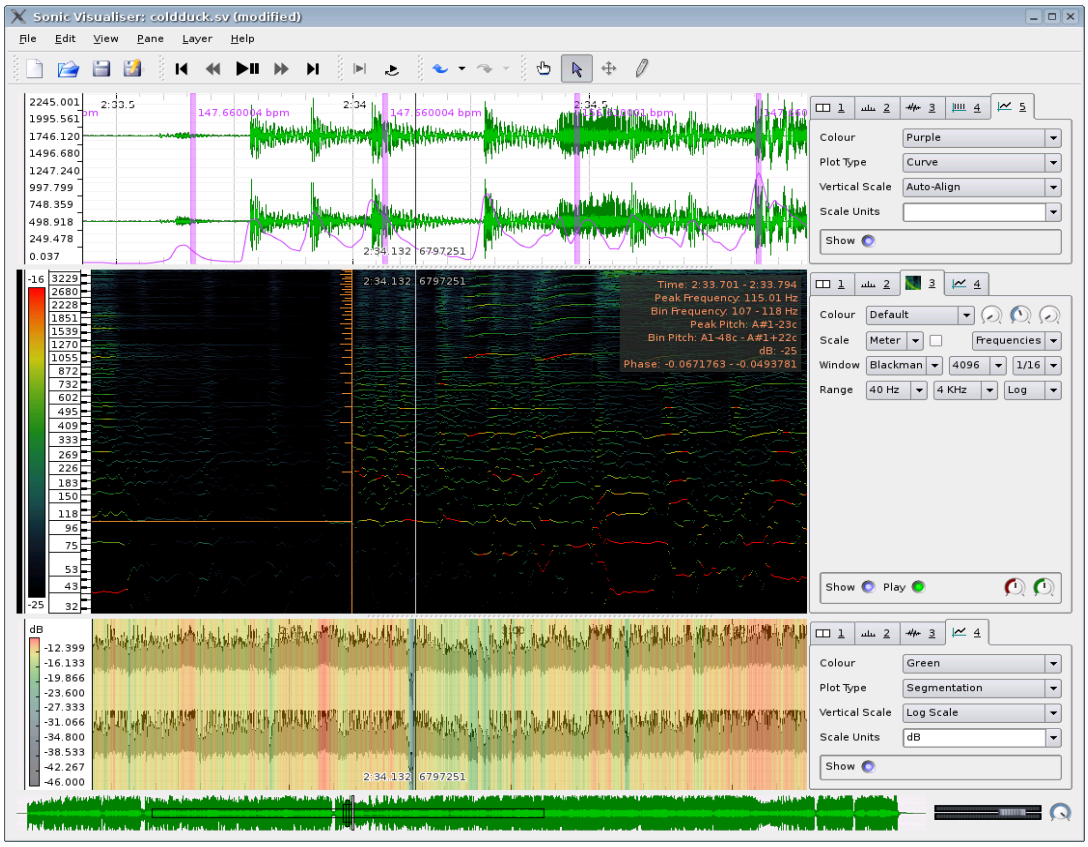
Katie Noland has already completed work on a pitch recognition algorithm (Noland 2009) which tracks the key of a given piece of music (N.B: the algorithm was applied to recordings of pop music that employ simple chord sequences). Noland was

developing a larger algorithm to create the cleanest pitch class profile possible. Then using this, she intends to apply it to key and chord recognition. Another researcher is engaged in the extraction of chord labels from audio (mostly from pop songs).

Other projects include research into: chord progression recognition and harpsichord recognition, pitch tracking, real-time note onset, semantic analysis of musical audio (particularly rhythm and harmony) and synchronisation of audio and other representations of musical data, in particular synchronisation of audio files containing different performances of a piece of music (specifically related to the Omras2 project). Harmonic sinusoidal modelling of sounds is also under investigation.

These new programs are mainly being written for Matlab (Ferreira, 2009) the programs that work best are then developed to run as plug-ins to the Centre's Sonic Visualiser program (see *Figure* 5.13), with the intention that all of the research work can then be made available to the research community on-line.

Figure 5.13 Sonic Visualiser 0.9 Screenshot



(www.sonicvisualiser.org/screenshots.html)

The screen shot illustrates

> The Sonic Visualiser 0.9 showing a waveform, beat locations detected by a Vamp plugin, an onset likelihood curve, a spectrogram with instantaneous frequency estimates and a "harmonic cursor" showing the relative locations of higher harmonics of a frequency, a waveform mapped to dB scale, and an amplitude measure shown using a colour shading. (www.sonicvisualiser.org/screenshots.html (2010))

Conclusion

On the basis of this review, automatic music information retrieval, as applied to large scale polyphonic music, is still many years down the line, however, there has been a steady acceleration of research into music information retrieval algorithm design over the last ten years and many of the core interests of music information retrieval researchers match to those of music therapists. Monophonic music retrieval is more advanced.

5.11. Relevance of Automatic Music Information Retrieval to Music Therapy Analysis

It is useful to note that current thinking in MIR (music information retrieval) research points to the value of devising MIR technology that meets the real needs of users rather than furthering the interests of developers:

> ISMIR *(The International Society of Music Information Retreival)* has tended to focus much less on the potential *users* of music-IR technology than on its developers. These users might include, for example, performing musicians, film-makers, musicologists, music librarians, sound archivists, music educators, and music enthusiasts of all types. The knowledge acquired by interacting with users like these can only improve the quality of the community's research output. It will also go a long way to helping ISMIR researchers create truly useful music-IR systems. (Byrd, et al., 2009. p18)

However, it is also important to note that the majority of working algorithms have been devised with pop music in mind. (Not surprisingly since most pop music is structured according to recognisable chord sequences and beat repetitions.) Byrd (2009) points out the seriousness of this problem:

> The vast majority of ISMIR's collective music-IR research has been conducted on Western popular musics of the late-20th and early-21st centuries. This is a serious problem because there is an enormous amount of music in existence that is utterly different from these corpora. There is no reason to assume algorithms that work superbly for the *Beach Boys* will do anything useful with Tuvan throat singing, *musique concrète*, or Indian Raga.
>
> (Byrd, et al., 2009. p17)

The author was fortunate to work closely with an experienced program developer to investigate whether a computer could be programmed to analyse the sorts of events that music therapists want to track and quantify. Our goal was not to attempt to map out all the acoustically derived material in notation form, the intention was to either build or adapt existing algorithms for the purpose of analysing music therapy test recordings.

By using the type of recording technology already described, many of the earlier music retrieval problems identified above did not on the whole hamper event retrieval, this is because each track was processed as a monophonic data strand and the performer of each instrument was known in advance.

As note retrieval from polyphonic recordings is under development, it is argued that in future, when mono tracks do contain additional audio spill from other instruments or voices, data recognition from mono tracks is likely to be achievable for some analysis tasks as applied to some instrumental sounds; for example, quantifying the duration of drum playing when the patient is known to be playing the drum and comparing this with the duration of MIDI keyboard playing when the therapist is known to be playing the MIDI keyboard.

In summary, the system will not be asked to process complex polyphonic music but to recognise certain types of events in one track and match or compare them to others recorded on other tracks.

Tempo Tracking

Establishing changes in timing of performance will be critical to some music therapy evaluations, particularly when the music therapist wishes to analyse changes in the patient's ability to build interaction sequences with the therapist (within improvisations) or when the timing of a note onset can indicate that the patient is listening to the therapist's music. Thus it is very positive to know that tempo tracking is already well established (Davies, et al., 2007, Davies, 2007). For test purposes a beat tracking algorithm (previously devised by Matthew Davies in 2007) was adapted to analyse tempo similarities between a therapist and a patient during an improvisation when the therapist played a MIDI piano and the patient played a metallophone. The algorithm was found to be sufficiently adaptable to track tempo similarity. (Details of the tests and illustrations of the test results are presented in Chapter 6). Therefore it is argued that quantification of changes in time based events will, in principle, be one of the easier computational analysis tasks when building the Music Therapy Logbook analysis algorithms.

Tracking Emerging Musical Structures

It should be noted that one of the main challenges to building effective music therapy analysis algorithms is the fact that much of the recorded material is likely not to behave according to the normal expectancies of musical phrase repetition, either melodically or rhythmically. Many music therapy improvisations consist of disordered exchanges of sounds in the first instance, although as the therapy process continues it may be the case that more organised phrases emerge. Therefore a music therapist user is likely to need algorithms that can track flexible beats that do not fit into any particular metre but approach and diverge from expected metrical regularity and sometimes match it.

Although this is a complex computational task to achieve, current thinking suggests that the future for MIR research is leading towards this kind of complexity: Byrd points out in his challenges for the future of MIR research that 'ISMIR research projects must dig deeper into the music itself'. (Byrd, et al., 2009.p17)

Tracking Musical Patterns

The fact that MIR researchers have concentrated efforts on phrase recognition will be of benefit to future research into algorithms for music therapy analysis. As previously discussed one of the key functions that UK music therapists want included in an evaluation tool is the ability to quantify changes in a client's repeated musical patterns or phrases, with a view to evaluating an increase in communicative flexibility within music play. Meaningful musical interactions in music therapy often require the therapist and patient to recognise the same phrase and play with it, by extending it or altering it. The ability of a computer program to recognise phrases and match them is highly applicable to the task of analysing interactive musical conversations between the patient and the music therapist, in which phrase recognition between the two players is central to the meaning of the event.

Identifying Changes in Vocalisation

As previously discussed, music therapists have also shown interest in a computer being able to track a patient's tonal vocalisations (and singing) in relation to the therapist's music and vice versa. It is clear from the research presented in this chapter that there has already been extensive work on identifying pitch, key changes and tonality so that it is likely that existing algorithms, (such as that devised by Noland, 2009) can provide the basis for further development work specifically related to the music therapist *as user.* However, as previously discussed, analysing musical recordings which contain a number of instrumental sounds and voices pose a more substantial challenge to music information retrieval researchers.

More research is needed before vocal data recorded from music therapy sessions can be accurately identified and tracked. It is suggested that the sampling techniques discussed earlier will go some way to reducing the complexity for the development of

a specific music therapy vocal analysis algorithm suitable for quantifying the amount of time a patient spends vocalising in an individual music therapy session when the therapist may also use his or her voice. This study has mainly focussed on the question 'What should be quantified?' rather than 'How can data be quantified?' since many of the latter processes are already well established and those that are not yet established require additional engineering expertise. (The example chart previously shown on page 121, merely shows how changes in the duration of vocalisation episodes across a number of weekly sessions might be represented by the Music Therapy Logbook system in future.)

5.12 Conclusion

The technologies reviewed in this chapter cover a wide range of applications, from recording devices, to audio editing programs and programs that are designed to extract and match different types of musical information from audio recordings. The proposed Music Therapy Logbook system requires both hardware and software. As has been shown, most of the hardware is already available, some of the algorithms required for identifying musical events from music therapy recordings are already proven, but although the field of music information retrieval is accelerating, it remains very much 'work in progress'.

The technical feasibility of using a multi-track, wireless audio recording system was tested and found to be useable. Since those tests were carried out advances in the design of recording equipment has been achieved so that, if preferred, a small eight channel recorder could be used instead of recording direct to a laptop computer. Recording directly to a laptop has advantages over using an audio recorder, as the audio files are immediately saved and stored on the device that will undertake the analysis, i.e. the computer. Whether a small laptop is sufficiently robust to cope with the ways in which music therapists work is yet to be tested, but has been proven possible.

Incorporating a performer identification system is feasible but more research and development work needs to be conducted to achieve an appropriate system, bearing in

mind the ethical and practical needs of music therapists and their patients. The actual technology required for such a system (for example radio frequency identification technology) has already been proved by others and is widely used in other applications. Furthermore, computerised evaluation programs are already in existence and being used by other health professionals in medical units, such as occupational therapists (Jiang, et al., 2006) so that ethical clearances for computational analysis is known to be possible.

The main music therapy analysis functions selected by UK music therapists in survey 4 were as follows: the identification and measurement of interactive episodes, the identification and quantification of repeated musical patterns, the quantification of time spent vocalising, and the comparison of time spent playing instruments as contrasted to using the voice. Based on the discussion of MIR research outlined above, current MIR research topics are well matched to the research needed to deliver these analysis functions.

However, the complexity of the work that lies ahead must not be underestimated. For example, further research is needed before complex analysis of musical interactions can be delivered. Investigating expected, as compared with unexpected, temporal musical behaviour would seem to be a possible starting point; beat tracking could provide a metrical grid against which the timing of music therapy interaction events could then be analysed.

On the basis of the research discussed above, identifying singing from instrumental activity depends upon the level of similarity between the voice and the instrument; the more difference there is between the voice and the instrument the easier it is. However, Identifying one voice from another voice, when both are singing at the same time, is likely to be very difficult.

Further collaborative research is necessary between MIR developers and music therapists before sophisticated automatic music therapy analysis can be realised. A combination of automatic analysis and semi-automatic analysis is more achievable and a more realistic goal for the short term.

CHAPTER 6: Testing the Prototype 1 Music Therapy Logbook System – A Proof of Concept Study

6.1. Summary of the Proof of Concept Study

Funding

A part time multi-disciplinary research team was convened by the author in January 2008 with funding from the White Rose Health Technology Innovation Partnership. The partnership is a consortium research organisation between the University of York, University of Sheffield, University of Leeds and their respective National Health Teaching Trust Hospitals.

Project Aims

The aim of the project was to prove the concept of using computational music analysis to help evaluate changes in a patient's and therapist's use of music over time when either player may use an acoustic instrument, in addition to, or rather than, a MIDI instrument. The clinical context was music therapy in neuro-rehabilitation settings. The project lasted twelve months.

Research Team

The research team comprised: Dr Andy Hunt (University of York), a senior lecturer in electronic engineering; Dr Josh Reiss (Queen Mary London), a senior lecturer in signal processing; Dr Matthew Davies (Queen Mary London), a post-doctoral researcher in music information retrieval; Mr Richard Caley (Mid Yorkshire NHS Teaching Trust), a clinical physicist specialised in assistive technology; and 2 music therapist researchers. The senior music therapist researcher (the author) was based part time in the Department of Music and part time in the Department of Engineering at the University of York. The clinical music therapist researcher, Ms Cath Roberts,

was already employed at the Osborn 4 Neuro-rehabilitation Ward, Northern General Hospital Sheffield NHS Teaching Trust. A third music therapist, Ms Janet Graham (Head Music Therapist, Nordoff-Robbins North East), field tested the prototype recording system at the neuro-rehabilitation unit of the Hawthorns Residential Home, Peterlee, County Durham, UK. Two post-graduate engineering students, both registered at the University of York, collaborated with the author on investigating designs for the computer program interface; Ms Anna Bramwell Dicks and Ms Lian Zhang.

Research Team Administration

The research team was co-managed by the author with Dr Andy Hunt. The author managed the individual researchers, chaired research meetings, designed and arranged the test recording sessions, performed musical examples in the simulated test sessions and organised training for the external clinical music therapist who tested the system in the field. The author worked collaboratively with all of the researchers, but guided the overall development of the project, particularly the computational analysis tests carried out by Dr Matthew Davies. Dr Hunt acted as engineering consultant to the project.

Summary of Tests

Recording tests were conducted first in a laboratory setting (by simulating music therapy improvisations) and then in the clinical field by Ms Janet Graham. Both sets of recorded material were used for computational music therapy analysis tests. The analysis tests were derived from music therapists' user needs matched to existing computer coding which was adapted, in turn, to meet those needs.

Summary of Conclusions

Computational analysis of music therapy recordings is possible when a patient plays acoustic percussion instruments. The computational analysis tests were designed to monitor aspects of a patient's playing in relation to that of a therapist; both sets of tests (simulated and clinical) proved it was possible to identify, compare and monitor

changes in instrumental activity over time. Future research is needed to; investigate and test an appropriate performer identification system (if fully automatic analysis is to be built into the system), further refine the audio acquisition system, and to devise additional music therapy computational analysis functions.

Ethical Clearances

The funding application process contained no requirements for ethical clearance. However, mindful of ethical considerations, the author stated in her application that ethical approval would be sought from Sheffield Teaching Hospitals NHS Foundation Trust and Mid Yorkshire Trust if required.

On receiving approval for the project, no requirement for proof of ethical clearance was made by the White Rose Partnership. However, the application for research funding required collaboration with employees of the National Health Service; Mr Richard Caley and Ms Cath Roberts were both employed by the Health Trusts referred to above. These researchers were therefore already party to ethical agreements in their respective hospitals. Therefore it was agreed that the ethical clearance for Ms Robert's to discuss her music therapy work with the research team was the responsibility of Ms Roberts with her hospital employers. (Mr Caley was acting in a consultative role and his work with the research team did not involve any discussion of clinical work with patients.)

Ms Roberts informed the team that she would only be able to refer to summaries of her past clinical sessions and could not discuss any on going work with patients or give access to any reports on patients or release any recordings of music therapy. (Ethical approval for such tests would have taken longer to gain than the duration of the project itself). Ms Roberts was able to discuss extracts from her summaries of past clinical work with three individual patients. Ms Roberts removed all material that might lead to identification of these patients. Therefore, during the project, no music therapy sessions were observed at the NHS Teaching Trust sites. No recordings of any music therapy work with patients who had been, or were receiving music therapy treatment at the Health Trust hospitals, were used for the purposes of this research.

The external music therapist, Ms Janet Graham, was not working at either of the NHS sites and was not involved in any of the research team meetings (except the final meeting when the results of computational tests were presented). Ms Graham was therefore invited to test the recording system at the neuro-disability unit of the privately run Hawthorns Care Home in Peterlee, County Durham (in order to provide test recordings for the purposes of testing the computational analysis algorithms.)

A meeting was held to discuss the project with Ms Graham and the manager of the neuro-disability unit. Following the meeting, Ms Graham applied for and received ethical clearance from the manager of the unit to use the prototype recording system to record her music therapy sessions with three individual patients. The manager also gave his permission for the author to use the recordings for the purposes of this research. (Confirmation of this agreement is shown in Appendix 4, page 244.)

6.2. Overview of Multi-Disciplinary Research Work

Six research team meetings were held during 2008-2009 in which goals were set and results reviewed. The author prepared three research reports for the White Rose Health Technology Consortium, including a final research report. It was clear from the first team meeting that such a diverse team would not only need to contribute different types of knowledge, but learn how to communicate expert information to those with different areas of expertise and different attitudes towards research.

During the first meeting there was much discussion as to the meaning of the term ‘evaluation’ in the context of clinical music therapy. The scientists were very much in favour of a hierarchical approach, suggesting tests should be designed that could prove the progress of a patient through music therapy. In contrast, the therapists were keener to identify and quantify changes in the music, irrespective of whether they represented progress for the patient.

The clinical physicist suggested the following approach; identification of the events music therapists need to analyse then from these set up analysis milestones, then, based on expected norms, the system would be able to measure divergences.

The music therapists pointed out that not everyone with the same disorder or disability processes through music therapy in the same way and some music therapists believe inter-personal dynamics to be the core of the work. The music information retrieval engineers, who were new to music therapy, expressed uncertainty as to what music therapy was and what it was aiming for – could it even be more useful for the therapist than the patient? Video examples of music therapy were shown and audio examples were played in order to illustrate the individuality of each music therapy relationship.

By the end of the second meeting, the team were agreed on developing a set of computational analysis tasks that were robust enough to test, yet sufficiently meaningful to the music therapist researchers to be of use. It was agreed to define patient participation levels but to ensure that these were immediately relevant to the clinical music therapist researcher, who was working with patients on the neuro-rehabilitation ward at Sheffield General Hospital.

Describing patient participation levels proved to be fruitful because it helped the music therapists define what types of musical events to re-create in the sound studio, for later computational analysis.

By the end of the third research meeting, after the participation levels had been explained, the team agreed it would be pointless to try to build and test a scale of improvements. The original aim of the project needed to be adhered to, i.e., to prove that quantifying changes in a patient's and therapist's use of music over time was possible using computational analysis when either may choose to use an acoustic instrument in individual music therapy sessions.

The fourth team meeting discussed the results of the simulated music therapy recording tests and the resulting computational analysis results. The fifth meeting discussed the field test recordings and the second set of computational analysis results. The final team meeting concluded a review of the research project; a discussion was held concerning plans to apply for further research and development funding. Two research applications were submitted during the course of the following year, one to

the EPSRC, (Engineering Physics and Science Research Council) and one to the Wellcome Trust. Although one was short listed, neither applications were successful.

6.3. Definition of Music Therapy Participation Levels

A list of basic participation levels of musical engagement in music therapy was agreed. (These were not intended to include discreet musical information). The term 'musical activity' was defined as:

> Either the patient or the therapist or both are engaged in producing or listening to music, and/or producing or listening to sounds. The music and/or sounds may be pre-recorded, pre-composed or improvised spontaneously.

The musical participation levels were defined as follows:

LEVEL 1: A music therapy session was arranged but it was not carried out:

Music therapy does not happen because –

- Patient is too unwell
- Patient does not want to attend
- Patient is not brought to session

LEVEL 2: A music therapy session was arranged and carried out but the patient does not appear to engage with or relate to music offered by the therapist.

> The patient may or may not speak words in the session or use their voice non-verbally but this is not in the context of, or in relation to, a musical activity. Equally they may make contact with a musical instrument but there is no evidence that this is intentional.

LEVEL 3: During music therapy session the patient uses their voice non verbally.

During the session the patient uses their voice non- verbally within the context of (or in relation to) one or more musical activity.

LEVEL 4: During music therapy the patient uses an instrument/s

During the session the patient uses one or more musical instruments in the context of (or in relation to) one or more musical activities.

LEVEL 5: During music therapy the patient uses their voice and an instrument/s

During the session the patient uses one or more musical instruments and their voice non-verbally in the context of (or in relation to) one or more musical activities.

LEVEL 6: During Music therapy the patient uses words as well as non verbal sounds and instrument/s

During the session the patient uses one or more musical instruments and their voice – including the use of words - in the context of (or in relation to) one or more musical activities.

LEVEL 7: *During music therapy the patient uses words communicatively*

During the session the patient uses meaningful words – in the context of or in relation to one or more musical activities

LEVEL 8: *During music therapy the patient is able to move between meaningful words, non verbal sounds and using an instrument/s.*

During the session the patient uses one or more musical instruments and their voice, including the use of meaningful

words – in the context of or in relation to one or more musical activities

6.4. Defining Computational Analysis Tasks

Introduction

In this section the process by which the first set of computational analysis tasks were arrived at is discussed. In summary, the research took the following path: i) definition of the clinical context, a patient's diagnosis and the multi-disciplinary and music therapy aims arising, ii) selection of music therapy events from the therapist's music therapy session summaries, iii) selection of music events to be simulated, iv) definition of the computational analysis tasks.

Clinical Context

The author met the clinical music therapy researcher, Ms Roberts, at Sheffield General Hospital to define the musical events they would later attempt to simulate in the recording studio at the University of York, (to provide test material for computational analysis). Osborn 4 ward houses short term neuro-rehabilitation patients who have mainly suffered brain injuries. The patients are usually resident on the ward for about two months during which their longer term needs are assessed and a variety of therapies are offered. A multi-disciplinary team of doctors and therapists is supported by nursing staff.

Many of the patients are permanently disabled, many are in wheelchairs. Music therapy is offered to individual patients for assessment purposes and for weekly treatment sessions. Most of the patients need help in adjusting to their changed circumstances. Those particularly in need of psychological help are referred either to the music therapist or to the art therapist. This is because most of the patients on the ward are unable to make use of verbal therapy with a psychologist or psychotherapist. Music therapy is therefore primarily used to treat patients who are thought to need

help with expressing their emotions, rather than as a form of functional rehabilitation therapy.

The music therapy room is shared by the two creative arts therapists who are both employed part time and use it separately to see their patients. Unlike the other treatment rooms on the ward, the room is a recognisably individual space in which art work, art objects and a variety of percussion instruments share space with a piano and an electric guitar.

The Type of Patients Treated with Music Therapy

Ms Roberts described summaries of her past clinical work with three individual patients. All the patients had acquired brain injuries and two had received injuries under traumatic circumstances. For example, one patient had been assaulted when had gone to the rescue of someone else who was being beaten up; the assailants had kicked his head in. The patient had been left with multiple problems, including dysphasia. The patient knew what he wanted to say but was unable to express it.

Due to reasons of confidentiality, it has been agreed to detail discussions on Ms Robert's work with only one of these patients, patient W, in order to exemplify the process by which the musical events (for later simulation in the recording studio at the University of York) were defined.

Music Therapy with Patient W

Patient W was brain injured as a result of a motorbike accident. He had initially been diagnosed as being in a 'persistent vegetative state'. The term 'vegetative state' describes a person who is conscious but has no sense of awareness; the person is:

- not aware of their surroundings,
- not aware of bodily sensations, such as feeling pleasure or pain,
- not able to follow and understand speech,
- not able to have thoughts, memories, emotions or intentions of any kind.

(NHS 2010)

The term ‘persistent vegetative state’ indicates that a person has been unaware for more than four weeks. Mr W was brought to music therapy sessions in a wheelchair and a nurse assistant was present to help Mr W make contact with some of the percussion instruments. Ms Roberts played songs to him on her guitar and improvised music on an acoustic piano whilst the assistant helped Mr W to make contact with the percussion instruments placed around him.

During the time Mr W was attending individual music therapy sessions with Ms Roberts, Mr W had had his diagnosis altered to that of *minimally conscious state* because he had begun to show some small signs of awareness. The use of the term ‘minimally conscious state’ applies to patients who show some clear evidence of awareness and responsiveness (Headway, 2010).

Patient W’s change in awareness was thought to have been evidenced in one particular music therapy session. In this session the therapist had spent some of the time playing the piano and singing whilst an assistant had offered instruments and a beater for patient W to use. During the session patient W had played 2 instruments assisted by the assistant; first the wind chimes then the drum. His unaided playing had formerly been limited to grasping the wind chimes, for example when the assistant brought the wind chimes close to patient W he had grasped them. However, in this session patient W had also grasped a drum beater and played a drum steadily, even though this playing had also been assisted. During his sound making episodes the therapist had improvised with him at the piano.

Evaluation Questions Arising

The evaluation questions for the therapist concerned how far patient W had been showing awareness or merely experiencing a grasp reflex when appearing to beat the drum whilst assisted. His actions had resulted in a change in the sound but the question remained - how intentional had his actions been? Patient W’s beat may just have been a repetitive movement that may have had nothing to do with the therapist or the music (participation level 2) or it might have been an indicator of a change in awareness (participation level 4). If a computer program could have established that patient W had changed the tempo of his beating to match changes in the therapist’s

tempo, this would have indicated that patient W had moved to participation level 4 because patient W would have demonstrated intention in making those changes. In discussion, the therapist commented to the author;

> ‘If you can demonstrate changes in awareness through music therapy involvement this could have massive implications for a patient like patient W, both for the patient’s future care and future access to rehabilitation treatments after leaving the ward’.
>
> (Personal communication, Ms Roberts 2008)

Definition of Music Therapy Events

Drawing on the discussion of the clinical material arising from music therapy with patient W, two core musical events were defined:

> *EVENT 1*: As a result of a patient grasping the wind chimes, the music therapist’s improvisation style changes.
>
> *EVENT 2*: The patient beats the drum steadily with a drum beater whilst the music therapist improvises at the piano

For the purpose of simulating improvisations in the sound studio, it was decided to concentrate on the second event as the wind chime instrument is one of the most difficult instruments to control in performance. The core music therapy analysis questions arising from Event 2 were as follows:

- Does the patient play the drum at the same tempo as the therapist at the start of his drumming?
- Does the patient match changes in the therapist’s tempo when the therapist changes the tempo of his or her playing?

From these questions analysis tasks were defined; analysis tasks it is thought desirable for the proposed Music Therapy Logbook program to eventually deliver:

ANALYSIS 1: Identify and measure the length of passages of improvised music in which a patient is drumming.

ANALYSIS 2: Identify the tempo of a patient's and a therapist's musical beat.

ANALYSIS 3: Identify passages in which a patient's tempo is not influenced by a therapist's tempo (and vice versa)

ANALYSIS 4: Identify passages in which either player influences the other player's tempo.

ANALYSIS 5: Identify how often each of the players initiates a tempo change.

ANALYSIS 6: Identify passages in which rhythmic patterns are initiated.

ANALYSIS 7: Identify passages in which rhythmic patterns are imitated.

ANALYSIS 8: Identify passages in which the patient and therapist exchange rhythmic patterns, as in a conversation.

6.5. Simulating Music Therapy Improvisations (Lab Test 2)

Having defined the above music therapy computational analysis tasks, the next step was to create recordings of simulated examples of music therapy improvisations to be used for testing the analysis tasks. A recording session was arranged in the Music Research Centre at the University of York. The recording session was also used to test the recording system and for this reason, it was decided to create improvisations using a variety of different instrumental combinations. (Each instrument was recorded using the multi-track recording system previously described in Chapter 5.) Each of the

instruments used in each improvisation was fitted with an independent radio microphone.

The computer engineer required a number of graded examples to track changes in events over time. It was therefore decided to record sets of short improvisations using different instrumental combinations for each set. The improvisations were graded to represent progress steps over 12 weeks of therapy. One player improvised from the therapist's point of view whilst the other improvised from the patient's perspective. (The role play was not intended to illustrate psychological aspects of any music therapy relationship, merely to evoke appropriate musical material for later computational analysis). The test session was also recorded on video.

The author and the clinical music therapist researcher performed 6 sets of improvisations. Using two out of four available multi-track channels, the first set of twelve improvisations were performed on two conga drums; with each player performing on a separate drum. (Please refer to *Media Examples 2, 3* and *4,* with reference to *Figure 6.1*). Using three recording channels, the second set of twelve improvisations involved one player performing on both of the two conga drums, whilst the other player performed on the acoustic grand piano (Please refer to *Media Example 5, 6,* and *7,* with reference to *Figure 6.2*). Both sets of improvisations illustrated a graded set of changes in a patient's ability to establish tempo, respond to changes in tempo, offer changes in tempo and engage interactively. The early improvisations represented very little response from the patient whilst the later improvisations illustrated increasing levels of responsiveness.

The remaining improvisation sets each contained two improvisations. These were recorded to test whether the recording techniques were delivering sufficiently clean sound with regard to these instruments. Improvisation Set 3 simulated the 'patient' playing a soundbeam (Swingler 1994), whilst the 'therapist' player improvised using the piano (*Media Example 8*). Improvisation Set 4 included a soundbeam and a metallophone. In improvisation Set 5 the therapist played a finger piano whilst the patient improvised on a suspended cymbal. In Improvisation Set 6 the two therapists used their voices, mainly non-verbally (*Media Examples 9* and *10*). *Figures 6.1* and *6.2* show the aims of Improvisation Sets 1 and 2:

Figure 6.1: Test Session 1. Simulated Music Therapy Improvisation Set 1

FILE NAME Set Number	**Improvisation Aims**	**Performers E.S.= author**	**Channel 1**	**Channel 2**	**Channel 3**
080403152119 Set 1	1.Patient unable to play but makes gestures	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403152533 Set 1	2. Patient makes fleeting sounds with long silences	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403152802 Set 1	3. Patient makes fleeting sounds with less silences	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403153123 Set 1	4. Patient plays with unstable tempo with silences	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403153510 Set 1	5. Patient rarely establishes tempo	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403153847 Set 1	6.Patient tempo established more often	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403154230 Set 1	7. Patient tempo fully established and sustained	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403154559 Set 1	8.Therapist changes tempo but client does not imitate the changes	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403155041 Set 1	9. Patient initiates tempo change / therapist responds	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403160447 Set 1	10. Patient's tempo imitates changes in the therapist's tempo	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403160734 Set 1	11. Patient offers rhythmic patterns, Th responds	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X
080403161118 Set 1	12. Patient and therapist respond to tempo changes, imitate and initiate patterns	'Therapist' = ES 'Patient' = Cath Roberts	CONGA DRUM 1 THERAPIST	CONGA DRUM 2 PATIENT	X

Figure 6.2: Test Session 1. Simulated Music Therapy Improvisation Set 2

FILE NAME Set Number	**Improvisation Aims**	**Performers E.S.= author**	**Channel 1**	**Channel 2**	**Channel 3**
080403164212 Set 2	1.Patient unable to play but makes gestures	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403164608 Set 2	2. Patient makes fleeting sounds with long silences	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403164826 Set 2	3. Patient makes fleeting sounds with less silence	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403165056 Set 2	4. Patient plays with unstable tempo and with silences	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403165405 Set 2	5. Patient rarely establishes tempo	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403165746 Set 2	6.Patient tempo established more often	Therapist ES	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403170256 Set 2	7. Patient tempo fully established and sustained	'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403170535 Set 2	8.Therapist changes tempo but client does not imitate	Therapist ES	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403171232 Set 2	9. Patient's tempo matches changes in therapist's	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403171652 and 080403171935 Set 2	10. Patient initiates tempo change, therapist responds	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403172138 Set 2	11. Patient offers rhythmic patterns to therapist. Therapist imitates back	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist
080403172435 Set 2	12. Patient and therapist both change tempo, initiate and imitate patterns	Therapist ES 'patient' CR	CONGA DRUM 1 PATIENT	CONGA DRUM 2 PATIENT	Acoustic PIANO Therapist

6.6. Introduction: Analysis of Simulated Improvisation Tests

Collaborative Research Method

The test recordings were delivered to Dr Matthew Davies at the Centre for Digital Music, Queen Mary University of London at the end of May 2008. The collaboration consisted of the author defining for Dr Davies the type of analysis required, then Dr Davies investigating the best way to achieve this at the technical computing level. Dr Davies then prepared examples of analysis and the two researchers met to discuss the results and decide on the most appropriate next step.

Collaborating with a computer programmer was new for the author, collaborating with a music therapist was new for Dr Davies, whose expertise had previously been in developing algorithms to extract beat tracking from recordings of pop music. The two researchers needed to spend time explaining what was requested by one and achievable for the other. Therefore, although the author guided the direction of the computational analysis, the computational tests described below were achieved by a process of collaborative discussion between the two researchers; the technical application of algorithms to the recorded material was carried out by Dr Davies.

Cross Channel Interference

The signal acquisition method used to obtain the multi-recordings resulted in some cross-channel interference, where the microphone used to capture one instrument (e.g. a drum) also captured audio data from the other instrument (e.g. the acoustic piano). This interference was thought likely to be problematic for computational analysis of the separate tracks, as musical activity from one instrument could appear in multiple channels simultaneously, therefore limiting the analysis of the session. (Please refer to Media Example 1, Week 4, Drum Track, in which the cymbal is audible at 0.32).

To overcome this potential problem, a hypothesis was used that musical activity appearing across multiple channels at once should always be strongest in the channel from the microphone closest to the instrument being played. By identifying the channel with the strongest signal at each time instant, it was possible to suppress

much of the audio spill, to the degree that it was possible to listen back to separate tracks and clearly identify each instrument.

It was decided to run foundation analysis tests before more advanced analysis could be approached. As the role of each performer was identifiable from the recording notes, it was possible to compare the activity of the 'patient' player to the activity of the 'therapist' player. (In this respect the tests can be described as semi-automatic rather than fully automatic as performer identification was not necessary.)

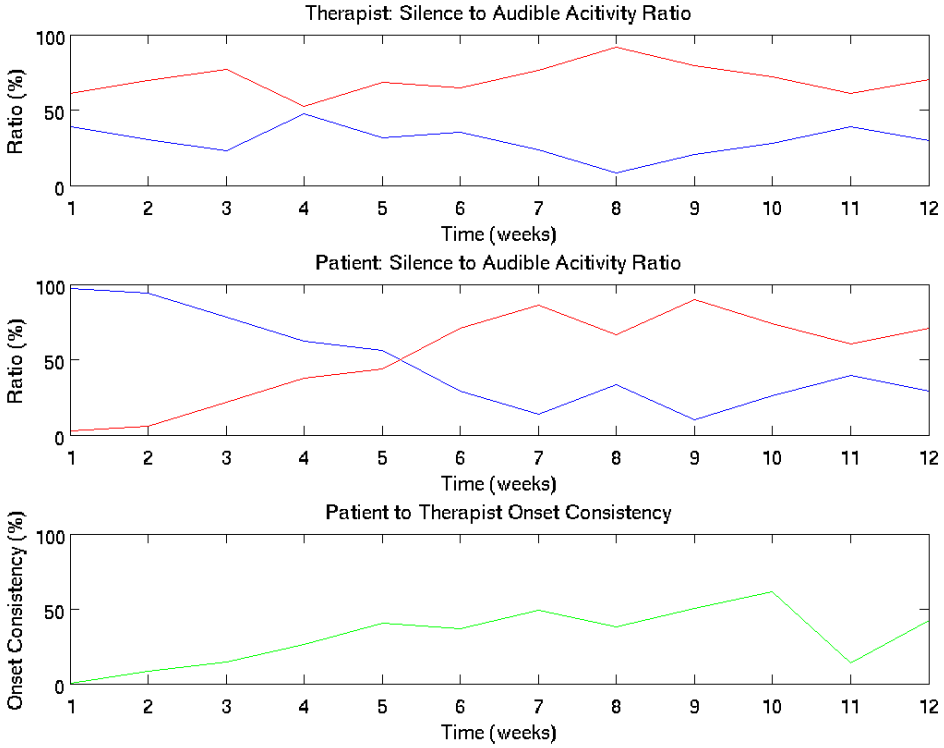
6.7. Computational Analysis Test 1: Improvisation Set 1: *Detecting Changes in Levels of Musical Activity Using Music–Silence Segmentation*

The foundation of all of the computational analysis undertaken for both sets of tests (simulated tests and clinical field tests), rested on being able to identify and isolate regions of musical activity within music therapy improvisations. The process of finding these regions is referred to here as *music-silence segmentation*.
By knowing when each instrument was played, any further computational analysis could be localised specifically to regions of interest. It was intended that this would both reduce computation time and improve robustness. The process of obtaining music-silence segmentation is based on the music information retrieval topic of *note onset detection* (Bello et al., 2005) the aim of which is to identify the starting points of musical events. The first stage in note onset detection is the generation of an *onset detection function* from a given audio signal. This is derived by an algorithm measuring changes in the properties of the audio over short time scales, in this case approximately every 10 milliseconds.

It was therefore agreed to investigate a foundation analysis task to compute each player's activity to silence ratio. Thus graphs were created to represent the silence versus audible musical activity ratio of both the players across each of the recorded improvisations in an improvisation set. Although the improvisations within each set had been created on the same day, it was decided to represent the activity to silence ratios for each of the twelve improvisations as if they had been computed from recordings of 12 weekly music therapy sessions.

Figure 6.3 shows an original screen shot of the first computational analysis achieved. The top graph represents the therapist's silence versus audible activity ratio, the middle graph represents the patient's silence versus audible activity ratio, the lowest graph plots the note onset consistency of both players, comparing how frequently the client's note onsets matched to those of the therapist within + or - 50 milliseconds. In the first two graphs musical activity is represented by the red line and silence is represented by the blue line. The lowest graph shows the level of note onset consistency of the players and is represented by a green line.

Figure 6.3: Computational Analysis Test 1 - Improvisation Set 1:
'Therapist' Conga Drum 1 / 'Client' Conga Drum 2



Computational Analysis Test 1: Improvisation Set 1: Discussion of Results

Computation analysis test 1 detected and represented changes in the two players' levels of musical activity. A steady increase in the 'patient's' playing from improvisation 2 through improvisation 7 was detected. This accurately matched the musical aims of the simulated music therapy improvisations in which the 'patient' player was at first unable to use the instrument, then gradually developed the ability to

use the instrument, increasing her level of skill as the improvisations proceeded, meanwhile the 'therapist' player's activity level decreased (as she reduced the amount of musical stimulation she gave to the 'patient').

On looking at the results, the lessening of activity in improvisation 8, a marked increase in improvisation 9, and then a drop in activity in improvisations 10 and 11, at first surprised the researchers. However, on consulting the improvisation aims, they realised that the changes in activity levels reflected expected changes in performance.

Figure 6.4 summarises the musical aims of the players in improvisations 8, 9, 10,11 and 12.

Figure 6.4: Musical Aims: Improvisation Set 1: Improvisations 8,9,10,11 and 12.

Improvisation 8	Therapist changes tempo but patient does not alter their tempo to match.
Improvisation 9	Patient initiates tempo change, the therapist responds by matching tempo.
Improvisation 10	Patient's tempo matches changes in the therapist's tempo
Improvisation 11	Patient improvises rhythmic patterns, therapist imitates rhythmic patterns
Improvisation 12	Patient and therapist both able to match tempo changes, initiate rhythmic patterns and imitate.

By comparing these aims with the computational analysis graphs (*Figure 6.3*) it is argued that computational analysis was able to identify and represent changes in musical activity levels representative of the growing ability of a patient and therapist to interact. In improvisation 8 the 'patient' used her conga drum less frequently due to the mismatch between the 'therapist's' tempo and her own; thus the note onsets were fewer. In improvisation 9 the 'therapist' adapted her tempo to that of the 'patient'; thus it was easier for the 'patient' to sustain her playing and her note onsets increased. There was a marked decrease in the musical activity of both players during

improvisation eleven when antiphonal exchanges occurred, so that whilst one player waited and listened the other played a rhythmic pattern.

It was not intended that the first computational analysis test, a foundation analysis test, would deliver particularly interesting results, merely prove the ability of a computer to track changes in general musical activity levels. However, the observed dip and recovery pattern in the onset consistency graph from week 8 through week 12 indicated that detection of antiphonal interaction episodes between therapist and patient may be possible using computational analysis when the players are using acoustic instruments. This finding is important because it seems more likely that music therapists will use a computational evaluation tool (like the proposed Music Therapy Logbook system) if it can detect and measure interaction episodes.

6.8. Computational Analysis Test 2: Improvisation Set 2: *Detecting Changes in Levels of Musical Activity Using Music-Silence Segmentation*

In Set 2 the 'patient' player used both the conga drums whilst the 'therapist' played an acoustic grand piano. The improvisation aims of Set 2 followed a similar pattern to those of Set 1: during the later improvisations the players were expected to illustrate how a patient might develop tempo flexibility, create rhythmic patterns, then engage in antiphonal interaction. (Please refer to Media Examples 5, 6 and 7).

It was decided to investigate whether a similar dip and recovery pattern in the onset consistency graph would emerge from the computational analysis of Improvisation Set 2. *Figure 6.5* shows the musical aims for Set 2 Improvisations 8,9,10,11 and 12. Improvising with these aims in mind was more complex for the players, given the fact they were not using simply one drum: one player improvised on two drums the other on the piano. However, after a number of attempts at ensuring that the musical behaviour required was in fact being improvised, a good set of examples was recorded.

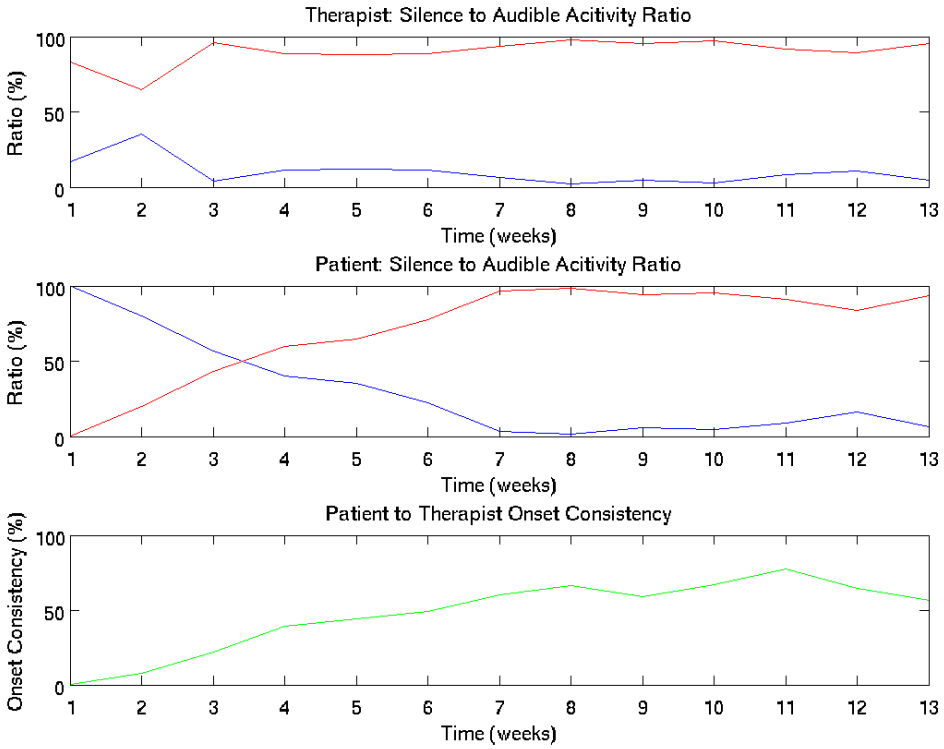
Figure 6.6 shows the computational analysis of the ratios of audible activity to silence, and the relevant note onset consistency graph.

Figure 6.5: Musical Aims: Improvisation Set 2: Improvisations 8,9,10,11 and 12

Improvisation 8	Therapist changes tempo but patient does not alter their tempo to match.
Improvisation 9	Patient's tempo matches changes in therapist's tempo
Improvisation 10	Patient initiates tempo change, therapist responds by matching
Improvisation 11	Patient improvises rhythmic patterns, therapist imitates rhythmic patterns
Improvisation 12	Patient and therapist both able to match tempo changes, initiate rhythmic patterns and imitate patterns.

Figure 6.6: Computational Analysis Test 2. Improvisation Set 2:
'Therapist' Acoustic Piano + 'Client' Conga Drums x 2

(Instrumental activity is shown in red, silence in blue, note onset consistency in green)



The computational analysis results of the Set 2 improvisations show a similar dip and recovery pattern in the silence to audible activity ratio from week 10 through week 11,

during which the ‘patient’ and ‘therapist’ players were more involved in waiting and listening. It is argued that the pattern appears less distinct in this analysis due to the fact that there was an overall increase in the musical material created in improvisation set 2, in which a piano and two conga drums were played.

The note onset consistency graph clearly shows the expected increase during improvisations 9 and 10 when the ‘patient’ was able to match the ‘therapist’s’ tempo and then offer tempo changes for the ‘therapist’ to match, so that the two players were increasingly playing in time with one another. In addition, the onset consistency graph shows an expected decrease during the improvisations in which listening and waiting increased.

The similarity of these patterns to those identified for Set 1, gives further indication that it may be possible to develop algorithms specifically to detect (and measure changes in the timing of) improvised antiphonal exchanges (interaction episodes) between a therapist and a patient, when both players communicate by improvising on acoustic instruments.

6.9. Using Bar Charts to Display Analysis Results

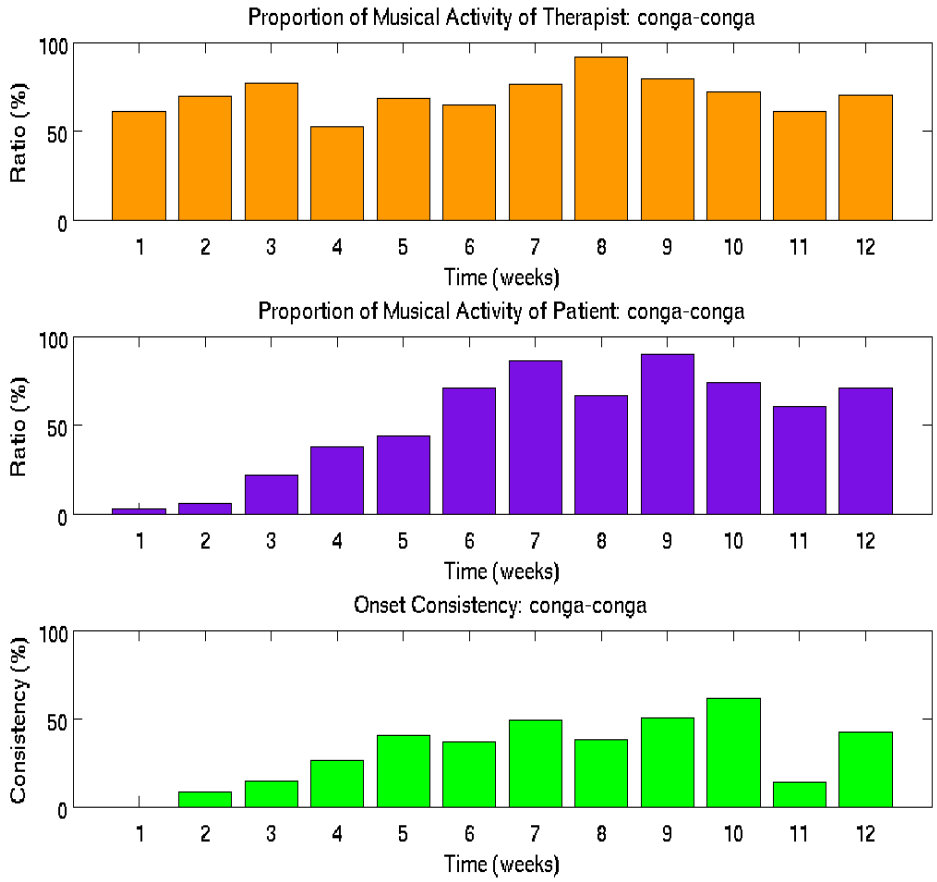
Illustrating levels of silence and activity at the same time is not necessarily the best way of illustrating changes in a patient’s and therapists’ use of an individual instrument over time. Thus simple bar charts were automatically generated in order to provide a comparison of playing activity over time and note onset consistency.

For the purpose of discussing whether this type of representation would be better understood than the previous type, the twelve improvisations were again represented as twelve weekly sessions.

However, it should again be noted that these improvisations were simulated by the author and the clinical music therapist researcher in the test recording session.

Figure 6.7 shows the bar chart representation of Improvisation Set 1:

Figure 6.7: Example of Bar Chart Representation of Analysis Improvisation Set 1: 'Therapist' = Conga 1 / 'Client' = Conga 2



Bar Chart Representation: Discussion of Results

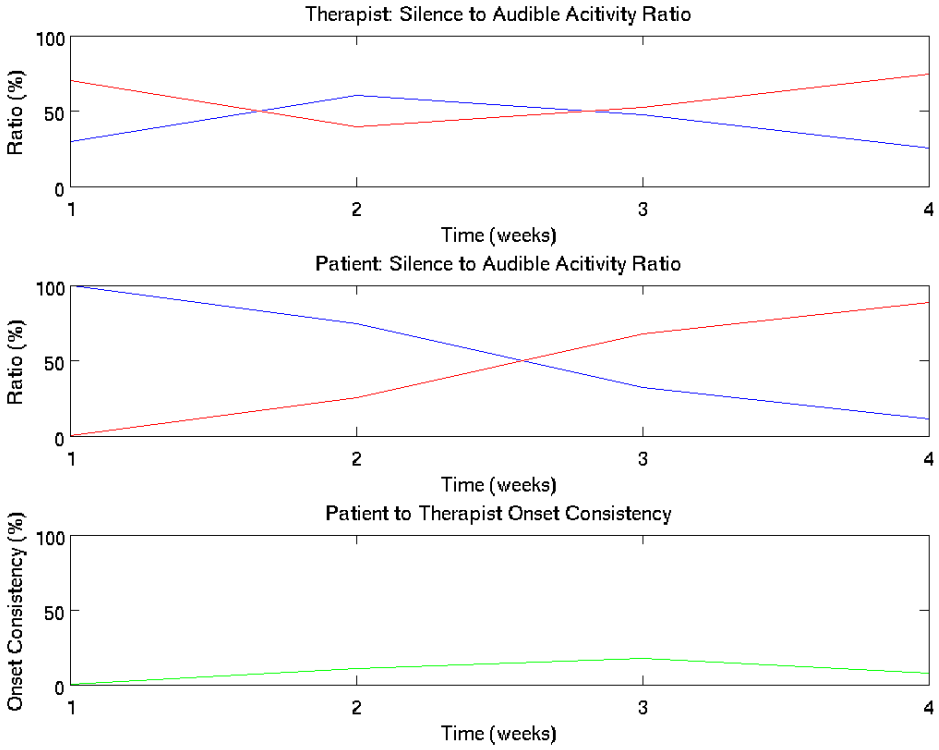
The gradual increase in the amount of time the 'patient' player spent in musical activity from session 1 through session 7 would seem to be more clearly represented in this type of illustration. The dip and recovery pattern in note onset consistency between the players is particularly clear through 'weeks' 9 - 12.

Therefore this type of representation was thought to be a better way for music therapist users to view the analysis results. Music Therapists are thought likely to easily understand these images and therefore can use them in reports, or for the basis of review discussions with non music therapist staff or carers.

6.10. Computational Analysis Test 3: Improvisation Set 3: *Soundbeam /Piano*

Improvisation set 3 included a soundbeam player (the 'patient') whilst the 'therapist' player improvised on the acoustic piano. Only two improvisations were recorded, as this was in order to test whether the recording system could deliver sufficiently separated sound tracks for computational analysis to be performed. Therefore only one improvisation was analysed by the computer (Please refer to *Media Example 8*). The soundbeam (www.soundbeam.co.uk) produces a radiating sound and there are no specific note onsets, such as occur in drum beating. The piano was used to reflect some of the abstract sounds produced by the soundbeam. The 'therapist' player used the instrument in very simple ways and did not offer complex tempo changes or rhythmic patterns. The aim was to illustrate a steady increase in a patient's' activity level.

Figure 6.8: Computational Analysis Test 4. Improvisation Set 3:
'Therapist' Piano / 'Patient' Soundbeam



Discussion of Results

From the graphs presented in the Test 3 analysis, it is clear that the 'patient' player's active use of the Sound Beam increased as the improvisation progressed. However, as fits the type of performance improvised on these instruments, the percentage of shared note onsets was shown to be extremely low.

Though no detail is available from the Test 3 results, it was still possible to track an increase in the 'patient' player's active play. The value of this should not be underestimated, particularly with regard to patients whose ability to move is severely limited, for example patients who can just manage to activate a soundbeam but are unable to play a musical instrument that requires more complex movements.

The simulated example aimed to illustrate a steady increase in the 'patient's activity level and this was able to be automatically identified by the computer and a diagram generated to show the change in the 'patient's' use of music over time.

6.11. Computational Analysis Test 4: Improvisation Set 6: *Vocal Improvisations*

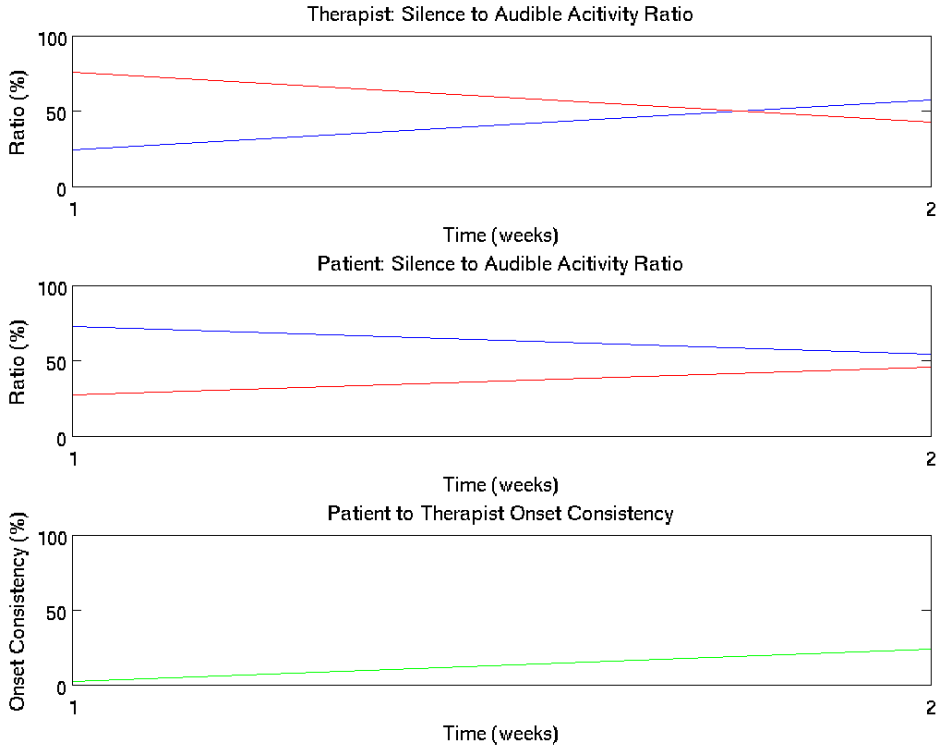
The sixth set of improvisations involved the two therapists in vocal improvisation. *Figure 6.9* illustrates the silence to audible activity ratios and the note onset results.
In order to ensure appropriate audio separation between the two singers, one singer moved into an adjoining side room in order to give the computer sufficiently separated audio data from which to analyse results. (Media Examples 9, and 10).

The analysis detected a progressive increase in the vocal activity of the singer who was simulating the patient, whilst the 'therapist' player reduced her vocal sounds to match that of the 'patient'. The recording and analysis tests of the vocal improvisations were undertaken merely to see how far it was possible to extract one singer's voice from the other when both were being recorded onto separate channels. However, it should be noted that it is unlikely that a real patient would agree to be fitted with an individual microphone, neither would it be regarded as good practice to attempt to gain permission for such use of a microphone, although some patients may

be happy to agree, (for example an adolescent attending a mental health out patient session).

If it proves possible to compute vocal data from live music therapy session recordings in future, then the type of data analysis shown in *Figure 6.9* is likely to be useful to music therapists who want to provide evidence of an increase in vocal activity. (For example, this would be particularly relevant to music therapy with stroke patients)

Figure 6.9: Computational Analysis Test 5. Improvisation Set 6:
'Therapist' voice 1 / 'Client' voice 2



Discussion of Results

In this analysis we see the therapist's activity decreasing to meet the rise in the 'patient's' activity. The 'therapist' is attenuating her input to match to the 'patient'. The onset consistency increases as the singers share more time in joint singing. In some instances, for example if a child is very isolated and uncommunicative with others, being able to show evidence of shared moments of vocalisation could be useful in arguing that in music therapy sessions, isolation decreases.

6.12. Summary: Analysis of Simulated Music Therapy Improvisations

By analysing simulated music therapy improvisations, when each player was identified as using a particular instrument, it has been shown possible to monitor one player's level of instrumental activity alongside that of another when both are playing on separate acoustic instruments. It has also been possible to compute increases and decreases in consistency of note onsets between the players.

Although it had originally been intended to carry out more detailed analyses of changes in timing and rhythmic organisation, within the time-scale of the proof of concept project this proved impossible (Dr Davies was only available for a limited amount of time). Therefore, these findings only suggest that it may be possible in future to detect and measure changes in a patient's ability to interact communicatively with a therapist through the implementation of computational analysis to multi-track audio recordings.

Presentations of the graphs and charts presented above were given at a number of conferences during 2008, 2009 and 2010 (Streeter, et.al.2008, 2009, Streeter, 2010). The response from music therapists was very positive. Perhaps this is partly due to the simplicity of the foundation analysis tasks; on the whole music therapists were left feeling optimistic; for example, a music therapist at the Royal Hospital for Neuro-Disability commented "Applying this type of analysis to recordings of our music therapy sessions would be very useful – after all its not rocket science!".

For this music therapist, the bar chart representations succeeded in allowing an easy and direct understanding of the data analysis, though the technology and computing that lie behind such analysis is complex. The music information retrieval experts laughed when they heard the comment; they retorted: "Its rocket science to us!".

6.13. Pilot Field Test Recordings

The clinical music therapist researcher, Ms Roberts, offered to test the recording system in her private practice at home. The recording system was used as a

replacement for her own audio recorder. (The recordings remained the private property of the music therapist; they were neither listened to by the author nor the research team, or used for later computational analysis). A training session was arranged at the University of York with a senior technician. The music therapist then transported the recording equipment to her home.

Ms Roberts was asked to report back on the training session and to report on setting up and using the recording system away from the university. (Her report is copied on the next page).

It should be noted that this therapist was already familiar with recording her own songs straight to her laptop computer; her comments therefore reflect her ease with technology in general. The instruments used were; one acoustic piano, one metallophone, one cymbal on a stand and a set of Rototom drums.

Suggestions for improving the system

The therapist suggested that a room microphone may be useful for those who want to listen back to verbal discussion as well as listening back to improvisations, and this could include patients. She also noted it would be important to know how to cut and edit the tracks, so that if necessary the therapist can remove the verbal discussion and only save the music play.

The therapist felt it was limiting to have to plan what instruments should be used in advance of the session (and therefore fitted with microphones). She reported this would be fine with less responsive patients but spontaneity is lost if patients want to play a wide variety of instruments or choose those that are different to their usual choices. (N.B: Only four recording channels were available).

The therapist reported that it would feel uncomfortable to wear a microphone, especially with anxious patients. She did not feel the use of personal microphones would be appropriate.

REPORT ON TRAINING FOR PROTOTYPE 1 MUSIC THERAPY LOGBOOK SYSTEM

Date: 21/7/08

Therapist's Name: Therapist X

1. What were your first reactions to being introduced to the equipment?

Daunted at first but quickly realised it wasn't that complicated. Also struck by the size of it i.e. bigger than expected, but if it was a permanent fixture in an MT room this would be fine. Not very portable in it's current format.

2. How easy was it in the training session to understand the technology?

1 [ ] Impossible to understand

2 [ ] Hard to understand

3 [ ] Quite difficult but not too bad

4 [ ] Fairly easy

5. [X] Easy

3. Please tell us how the training session can be improved if necessary:

The format of the training session worked very well. I liked the three components: 1. Demonstration of set up and application 2. Therapist sets it up from scratch, demonstrates this to technician 3. Therapist packs it away again under supervision of technician This seemed ample to me, it was good to know there was a technician at the end of a phone even though in the end I didn't need to call.

4. How easy was it to set the equipment up at your place of work?

1	☐	Impossible
2	☐	Very hard
3	☐	Quite difficult but not too bad
4	☒	Fairly easy
5.	☐	Easy

5. Please elaborate on your answer to question 4. We'd like to know what it was like setting up the equipment – any challenges you might have faced and how you resolved them, or not.

Only slight rearrangement of the room was needed to fit the equipment in. Looks quite neat when it's all set up. Mic's tucked out of the way nicely. Biggest challenge was finding something to attach mic to inside an upright piano, in the end had to sacrifice the soft pedal. Also mic's 2 and 4 seemed unpredictable -only worked after an hour (either through lots of fiddling or the equipment just warming up?)

6. What would have made it easier to set up the equipment?

A smaller flight case. The one supplied is bigger than it needs to be. A pack of blue tack in the kit and maybe strips of Velcro as well.

7. Please give your overall feedback on the equipment - what you found easy or difficult

I found the software fairly easy to use but I think it's quite complicated for people who may not be that computer literate and it certainly looks daunting. I wasn't aware from my training session that I need to alter the levels so I didn't in the first session. Only difficulty with this is not being able to see the computer screen when you have to walk across the room to test the level on the piano etc. Also I was unsure if I had to adjust the levels on the M Audio box or on the Radio Mic Boxes in the flight case.

6.14. Field Test Recordings: Hardware and Software

The next phase of the research was to test the recording system in the field. Ms Janet Graham (head music therapist, Nordoff Robbins North East) offered to independently test the system. The system used off the shelf equipment and this was sourced and assembled into a recording kit by technicians at the University of York:

Radio Microphones

Dual channel UHF microphone systems were chosen from W-audio model number TPT-202. With two dual units this allowed the recording of four channels simultaneously as the microphones all work at different UHF frequencies as shown below:

- Microphone1: 863.65 MHz
- Microphone 2: 864.82 MHz
- Microphone 3: 863.13 MHz
- Microphone 4: 864.05 MHz

The radio microphones were intended to be used for recording instruments during the music therapy sessions. The receivers were connected to the External Sound Card as described below.

External Sound Card

The external sound card was a multi-channel I/O system from M-Audio called the M-Audio Fast Track Ultra. It has many functions but for this project only four of the six balanced line inputs were used as inputs from the radio microphone receivers. The Fast Track Ultra digitised the audio signals at up to 24bit/96KHz ; the sound card was connected to the PC system via a USB 2.0 port.

PC System and Software

The PC used was a Dell laptop running Ableton Live7 professional audio recording software. The software allowed all four channels to be recorded at once into a 'Live Set'. (A screen shot of a Live Set page is shown in *Figure 6.10.)* Once the session had finished the 'Live Set' was to be saved by the music therapist. Subsequently the

computer engineer could extract the individual tracks recorded from the microphones and save these as WAV file formats for processing and analysis. (A master track containing all the audio was also saved as a separate WAV file).

Figure 6.10: Ableton Live Set Screen Shot

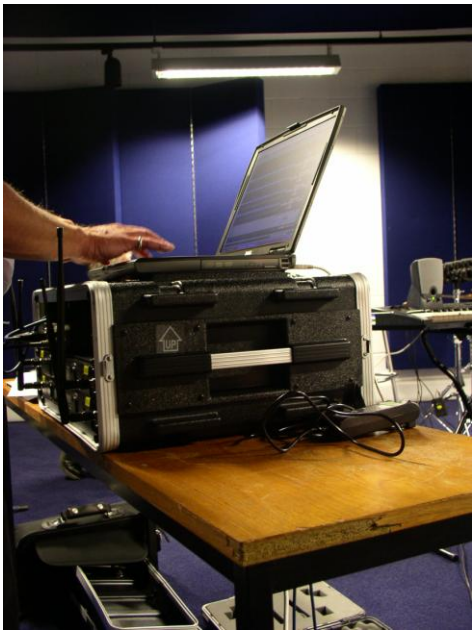
(http://www.ableton.com/live)

Packaging

The two radio microphone receivers and the external sound cards were mounted by technicians into a standard 19" rack case and it was intended that this and the radio microphones would stay in the music therapy room, although they could be moved if needed. The laptop would then be brought to the room and connected to the rest of the equipment by the music therapist who would plug the USB cable into the laptop and run the software. Both the therapists who tested the system reported that the equipment seemed far too large for general use. It is intended that the next system to be tested will be smaller. *Figure 6.11* shows a test session at the University; the laptop rests on top of the flight case rack which contains the receivers and external sound

card. (Please refer to *Media Example 11* for detailed photographs of the microphone and equipment set up)

Figure 6.11: Testing the Recording Equipment at the University



6.15. Field Test Recordings: The Clinical Site

The Hawthorns Care and Neuro Rehabilitation Centre is situated in a quiet hospital complex, one of a number of such units run by the private health care company, Barchester Homes. The centre supports people with acquired brain injury, Huntington's disease, people with minimal consciousness who need ventilator care, those with motor neurone disease or multiple sclerosis, and people with Parkinson's disease. The rehabilitation centre provides both long term care and respite care. The majority of the clients receiving music therapy have enduring neuro-disabilities or degenerative illness.

The music therapy room is used by a number of different therapists at different times during the week. The musical instruments are stored in the music therapy room.

6.16 Field Test Recordings: Training a Music Therapist to Use the System

Three telephone conversations took place between the author and the external music therapist, Ms Graham, prior to the clinical field tests. Ms Graham, although keen to help with the research, felt very unconfident about using new equipment. The author avoided discussing any of the technical details but reassured her that the purpose of the tests was just that – to test whether a music therapist, who had not been involved with the research, could use the system; even if nothing was recorded she would still be making a useful contribution. It was felt important that the author did not describe the equipment, or the use of the equipment, prior to the training session.

A two hour training session took place in the music therapy room at the clinical site. In order to ensure the training was not influenced by the author, the author remained outside of the room whilst the senior technician from the University of York explained how to use the equipment. The music therapist was shown how to attach the radio microphones to the percussion instruments, how to set up and switch on the receiver boxes and the external sound card, and how to name the Ableton 7 'Live Set' files in the laptop computer. She was also shown how to connect her MIDI keyboard with a USB lead. (The piano in the music therapy room was a MIDI electric piano. In addition, the piano was recorded using one of the radio microphones).

The music therapist was left with the equipment and an instruction sheet prepared by the technician. She was asked to fill in a training report form (prepared by the author) and to return it with her session recording reports (prepared by the author) at the end of the clinical test period of five weeks.

The music therapist reported back that she could not set the audio input levels and needed clearer guidance on this; (this resulted in some of her recordings being unsuitable for later analysis). The therapist wanted an easier way of attaching the microphones to the instruments. The therapist's report form indicates that she was less familiar with using technical equipment and less confident in her ability to use it, than the clinical music therapist researcher. However, the clinical music therapist researcher had been involved with the project from the start.

REPORT ON TRAINING FOR PROTOTYPE 1 MUSIC THERAPY LOGBOOK SYSTEM

Date: 24/09/08

Therapist's Name: Therapist Y

1. What were your first reactions to being introduced to the equipment?

It looked very big and complicated. I'm not very technically minded and was a little anxious that I wouldn't be able to understand how to use it.

2. How easy was it in the training session to understand the technology?

1		Impossible to understand
2		Hard to understand
3		Quite difficult but not too bad
4	X	Fairly easy
5.		Easy

3. Please tell us how the training session can be improved if necessary:

New equipment tends to make me panic and I feel worse when I'm being observed trying it out. I'd suggest allowing 20 minutes for the therapist to set it up alone and try it out, then come back and discuss any areas of difficulty. The instructions were clear to follow once I got over the panic stage!

4. How easy was it to set the equipment up at your place of work?

1		Impossible
2		Very hard
3	X	Quite difficult but not too bad
4		Fairly easy
5.		Easy

5. Please elaborate on your answer to question 4. We'd like to know what it was like setting up the equipment – any challenges you might have faced and how you resolved them, or not.

I had to refer to the instructions each week, mostly because I'm not very confident with equipment. I was never sure that all the tracks were recording, possibly because it's a small room and the instruments are quite close together. It was difficult attaching the microphones to the guitar and to the tambourine.

6. What would have made it easier to set up the equipment?

If it had been more compact, and if I could have left the microphones attached to the instruments all the time, if it were easier to see whether the microphones were working. I'm sure it would have got easier over time.

7. Please give your overall feedback on the equipment - what you found easy or difficult

I only hope that the recordings came out alright. It was fairly straightforward in general. My main dislike was the time it took to set up at the beginning of the day, but this is mostly because I am not very good at this sort of thing! I haven't had time to listen back to any of the recordings, and didn't know how to check that they were alright.
It was easy to connect up the laptop and use the software.
It wasn't easy to attach the microphones to the instruments. It wasn't possible to set the channel recording levels.

6.17 Field Test Recordings: Therapist's Test Reports

Ms Graham used the prototype system to record her individual music therapy sessions with three clients over a period of five weeks; on one of these weeks the music therapist was ill and unable to go to work. She was asked to fill out a recording test report for each of the sessions she recorded. The reports were helpful in gathering information on her use of the equipment in situ, her aims for each of the music therapy sessions, and a brief description of the session.

The reports were later used by the author in collaboration with Dr Davies to determine, in discussion with the therapist, the type of computational analysis tests that should be attempted. (The clinical field test recording reports can be viewed in Appendix 5.)

6.18. Field Tests: The Music Therapy Patients

A brief overview of the patients whose sessions were recorded follows. (The patients had all been receiving weekly music therapy for several weeks prior to the test recordings; the patients were all used to having their sessions recorded.)

Mr B had an acquired brain injury caused by a road traffic accident, resulting in cognitive impairment including short and long term memory loss. He had quite severe mood swings and a tendency to get stuck in repetitive spoken phrases.

Mr C had suffered an anoxic brain injury following collapse and seizure which it was thought may have been provoked by alcohol withdrawal. The possibility of Korsakoff's syndrome was being investigated. Mr C had very limited movements so he was a wheel chair user.

Mr T had suffered brain damage as a result of a subarachnoid haemorrhage. He had mild cognitive and memory problems, suffered from severe epileptic seizures and was only able to use his left arm. Mr T was also a wheel-chair user.

6.19. Profile of Patient Mr B.

Mr. B. had been living in the rehabilitation unit for two years. He had been involved in a car accident in which he had suffered a fractured skull and fractures to his right arm, the neck of his right femur, right tibia and right fibula. This led to cognitive impairment and memory problems as well as the need to use a wheelchair. His mood fluctuated and it was reported that he could become verbally aggressive. Mr B often showed confusion and disorientation and was very reluctant to join in shared activities, spending most of the time by himself in his room.

He had started attending music therapy when he first arrived at the unit but had then stopped attending. A few weeks prior to the start of the field test recordings Mr B was so isolated that he hardly left his room, refusing to join in with any activities or outings. Shortly after this time he asked to start his music therapy again. The therapist described this as "a little window" with which to work. At the time of the recordings, Mr B needed help to get from sitting to standing, and the physiotherapists were working towards more independence in his transfers and general mobility. His hand dexterity and fine motor control were also poor.

6.20. Music Therapy Aims

The main aims of the multi-disciplinary team were to help improve Mr B's mobility and to encourage his social skills. The music therapist was focussing on the latter aim. One objective was to help Mr B experience increased flexibility in his music making with the therapist, in particular to try to help him reduce the number of times rhythmic phrases were repeated which, when played quickly and continuously, were thought not to be intentionally communicative but habitual. Mr B had told the therapist, "This is what I'm like, I always go too fast".

The music therapy approach being used with Mr B was the Nordoff Robbins approach. The therapist aimed to widen the range of Mr B's tempi, and to try to slow his playing down by improvising slower music with him. In one of the sessions Mr B remarked "Life is like music therapy, we make it up as we go along". At the heart of the work with Mr. B was his growing recognition that the music therapy experience is a shared

process in which flexible rather than fixated ways of behaving can be explored and tried out. He did not have to remain stuck in his room. At the time of the recordings he was starting to join in with group activities again.

6.21. Field Test Recordings: Introduction to the Computational Analysis Process

It is not within the scope of this thesis to detail all of the computational analysis work applied to the field test recordings. The aim here is to describe the processes by which computational analysis tasks were arrived at, and to present the most comprehensive computational analysis test results. About half the test recordings were unable to be used for computational analysis. This is because i) the recording levels had not been set for a number of the recording sessions (and therefore in some instances the audio signals were too low) and ii) patients did not attend their sessions. It has therefore been decided to describe the analysis work arising from the work with Mr B and to present mainly the results of the analysis tests applied to those recordings. (All of the therapist's *recording reports* are available to view in Appendix 5. In addition, *computational analysis reports* on all the recordings undertaken by the therapist are available to view in Appendix 6 – these were compiled by Dr Davies.)

6.22. Defining Evaluation Questions to Test Computational Analysis

After the conclusion of the test recordings, the author and the therapist discussed what type of evaluation questions she wanted to ask of computational analysis. Drawing on her music therapy aims for each of the recorded sessions, it was possible to reduce her ideas down to three evaluation questions:

1. Can computational analysis identify changes in Mr B's overall flexibility; for example identify how often he initiates an improvisation rather than merely joining in with the therapist's playing?

2. Can computational analysis deliver evidence of changes in the amount of time Mr B spent repeating his habitual rhythmic patterns?

3. Can computational analysis identify whether the therapist's metric changes were effective, or not, in increasing the patient's tempo flexibility?

The first question relates to one of the therapist's main goals for Mr B's music therapy, to help him gain experiences of flexibility, rather than fixedness. The second question relates to a more detailed evaluation of the rhythmic properties of his music; were his repetitions decreasing and/or slowing down? The third question relates to the music therapist's interventions; she wanted to find out if, for example, by changing to triple from duple time, then cutting across his beat, she was helping to slow Mr B's tempo.

6.23. Summary of Computational Analysis of Field Test Recordings

Four types of automatic computational analysis were applied to the recordings; music-silence segmentation, tempo tracking, characterisation of rhythmic phrases, and melodic tracking, (so far as this related to the melodic character of a rhythmic phrase). The following sections describe the tests in more detail, screen shots of the computational analysis results illustrate the results.

6.24. Field Test Recordings: Mapping Instrumental Activity

As previously discussed, the foundation of the computational analysis rested upon being able to identify and isolate regions of musical activity within music therapy improvisations. It was decided to find a way of representing the ratio of playing activity between therapist and patient with respect to all the separate instruments which Mr B and the therapist played in each individual session. The aim was to create a summary visualisation of each music therapy session, so that these could then be compared.

An example of an instrumental activity map is shown at *Figure 6.12* in which the amplitude levels of each instrument played are first illustrated and then a summary of

the use of instruments over the whole of the session. In Mr B's sessions, the therapist only ever played the MIDI piano; all other instruments were played by Mr B. The final section of piano play (starting at about minute 22) is a piano duet with Mr B in the treble and the therapist in the base.

The MIDI track from the electric piano was used in preference to the acoustic piano track. The piano information shown was captured as MIDI data and then converted to audio using Timidity1. For this music-silence segmentation task we did not need to know the precise positions of the note onsets; our interest was in finding larger regions where groups of musical events occurred. To this end, Dr Davies converted the onset detection function into a *musical activity function* by measuring the energy in the onset detection function over 5 second windows, with a 1 second increment over the length of each channel.

The audio signal acquisition method resulted in a small amount of cross-channel interference. By identifying the channel with the strongest signal at each time instant, it was possible to suppress most of this interference. (N.B.The individual instrumental tracks contained in *Media Example 12* have not been subjected to cross channel interference suppression).

To listen to the music therapy session, please refer to *Media Example 12*. Mr B. Week 2: Instrumental Mix. This is a mix of all the instrumental tracks which were recorded during this session. In addition, each of the separate tracks is available to listen to. The verbal discussions between the patient and therapist have been replaced with silence. Please refer to the analysis map *Figure 6.12* to find the start and end points of improvisations referred to in the text.

Figure 6.12 shows the analysis: the electric piano in white always occupies multi-track channel 1. The percussion instruments occupy the remaining channels and are colour-coded as follows; the metallophone playing is shown in orange, the side drum in red and the wood block set in brown. *Figure 6.13* shows measurements of the duration of each player's instrumental activity, as automatically computed from the music-silence segmentation analysis.

Figure 6.12: Field Tests: Music-silence segmentation: Mr B. Week 2.

(a)-(d) Musical activity levels for each channel of the multi-track recording.
(e) The summary visualisation of musical activity across all channels.

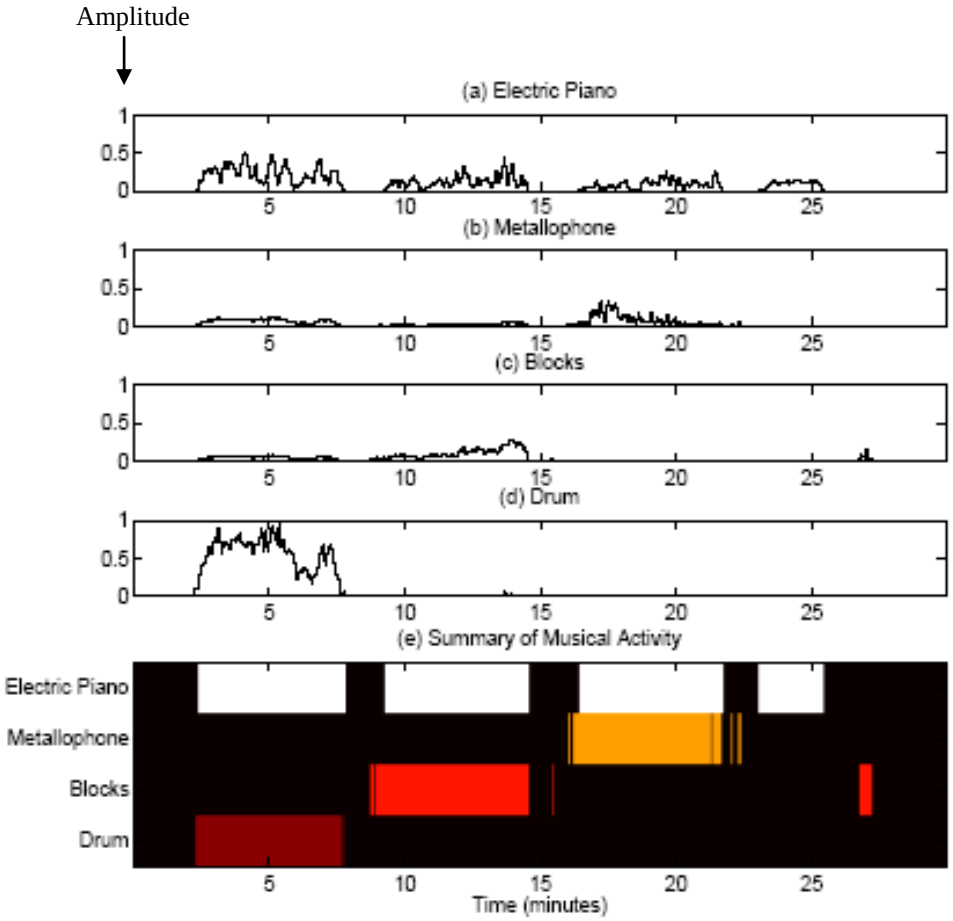


Figure 6.13: Field Tests: Instrumental Activity Measurements: Mr B. Week 2.

Instrument	*Percentage Activity*	*Duration (in minutes)*
Electric Piano	61.9	18.5
Metallophone	19.0	5.7
Wood Blocks	21.2	6.3
Side Drum	18.2	5.4
Total Therapist	61.9	18.5
Total Patient	58.4	16.4

6.25. Purpose of Music-Silence Analysis of Music Therapy Recordings

Music silence segmentation is not intended to measure improvements in a patient's behaviour or condition, all it does is produce quantitative data for music therapists to interpret in relation to their treatment goals and their subjective notes. Therefore this type of analysis provides basic information on the *instrumental activity relationship* between a therapist and a patient. The test results illustrated in *Figures 6.12* and *6.13* show that when, prior to the analysis, the player of each instrument is identified, it is possible to –

- Measure the amount of time a patient spends playing each different instrument.
- Measure the amount of time in which the patient does not play.
- Produce similar measurements for the therapist's instrumental activity.
- Identify the amount of time a patient and therapist spend playing together.
- Identify the order in which the instruments are played.
- Identify who starts and stops each improvisation.
- Identify whether the instrumental activity of the players is mainly happening at the same time or separately.

6.26. Relevance of Music-Silence Segmentation Analysis to the Evaluation of Music Therapy with Mr B

The therapist already knew that Mr B usually played when she played. She interpreted this to mean that he was trying to be polite and comply with what he thought she wanted. They were often joined in long improvisations in which Mr B could not find an ending; he tended to play in repetitive patterns, continuing until he began to tire. The therapist would try to signal stopping points by slowing her music or creating cadence points. It often felt to the therapist that Mr B was on automatic. The therapist felt concerned that Mr B might not be attending to what he was playing, merely losing his attention in the activity. She was also concerned that the length of the

improvisations was physically tiring him. Taking into account the final play time of the therapist and Mr B at the piano (Mr B. can be heard in the treble and the therapist in the bass) the instrumental activity measurements confirm they were playing for similar amounts of time, also that Mr B spent long periods of time playing each instrument. For example, in Mr B's 20th clinical session (Mr B Week 2) the computational analysis measurements show Mr B played the woodblocks for just over 6 minutes continuously, with the therapist playing the electric piano.

Figure 6.12 (e) indicates that Mr B started the woodblock improvisation, then later started the metallophone improvisation. However, it cannot be argued that he was initiating these playing episodes from this analysis alone. Video analysis would be necessary to clarify whether, for example, the therapist may have looked at Mr B to signal that he should play. Therefore, the only purpose of such measurements is in providing therapists with data that they can use to compare changes in a patient's use of instruments in relation to their own playing over a series of sessions. In other words such measurements need to be interpreted by the therapist. In the case of Mr B a positive change might be illustrated by showing evidence of decreasing numbers of improvisations in which the patient and therapist start playing together. (With a different patient evidence of playing together might indicate a positive change).

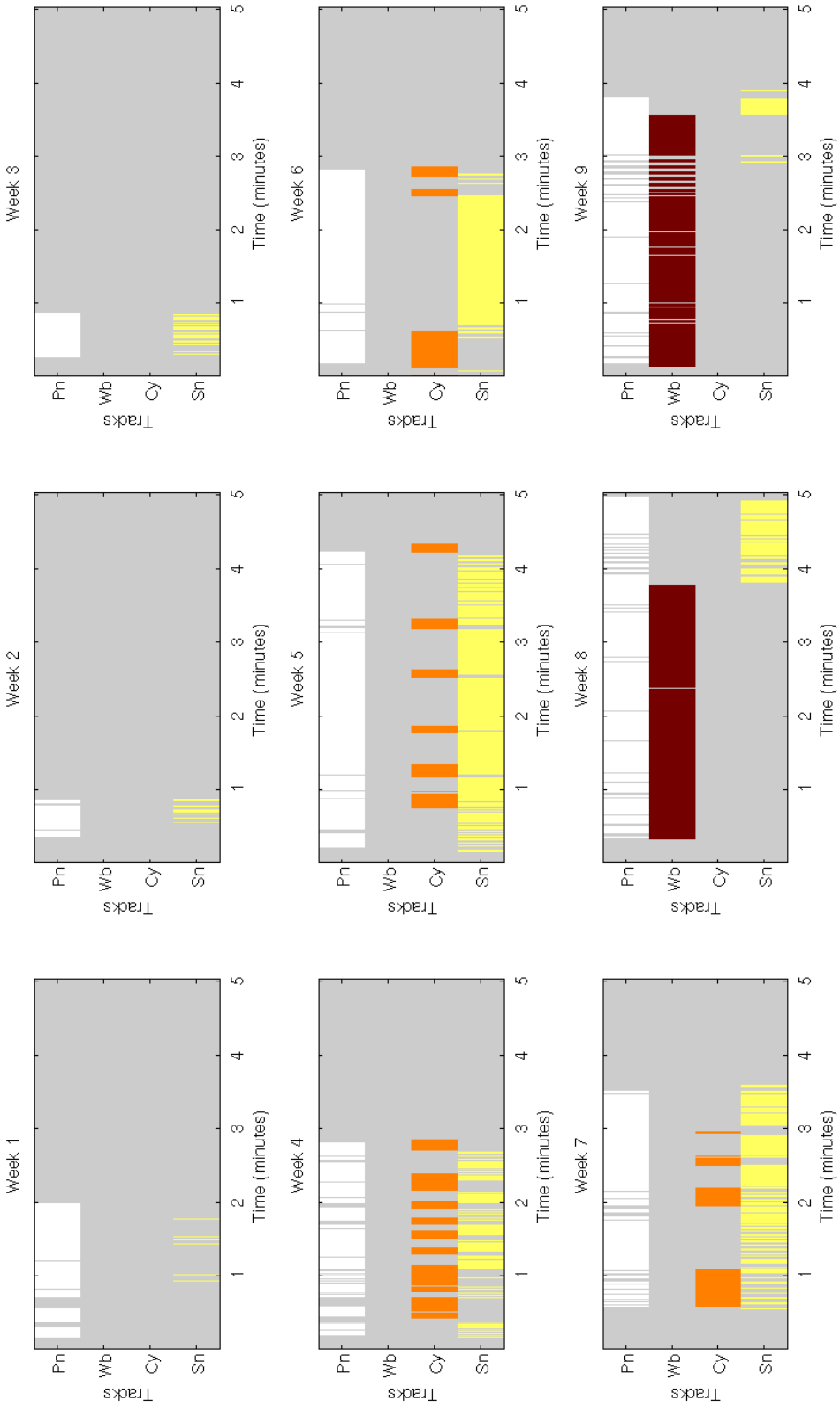
6.27. Mapping Changes in Instrumental Use across a Series of Sessions (Lab Test)

The author wanted to investigate if, by viewing a series of maps, it would be possible to identify general changes over a period of weeks; for example, an increase or decrease in the patient's use of a particular instrument, how frequently the patient and therapist play together, how frequently the therapist plays alone, whether the patient's choice of instrument varies, and whether the music itself appears to employ conversational (interactive) exchanges.

It was decided to simulate a set of nine improvisations using similar instruments to those used in Mr B's music therapy at the University of York. *Figure 6.14* shows a screen shot of a map series: the maps show computational analysis as applied to the first five minutes of each 'week'. The 'patient' player had access to a snare drum, a cymbal and a set of woodblocks, the 'therapist' player used only an acoustic piano.

Figure 6.14: Lab Test 1: Automatic Mapping: The First Five Minutes of 9 Simulated Sessions

Piano = white, Woodblocks = brown, Cymbal = orange, Snare drum = yellow

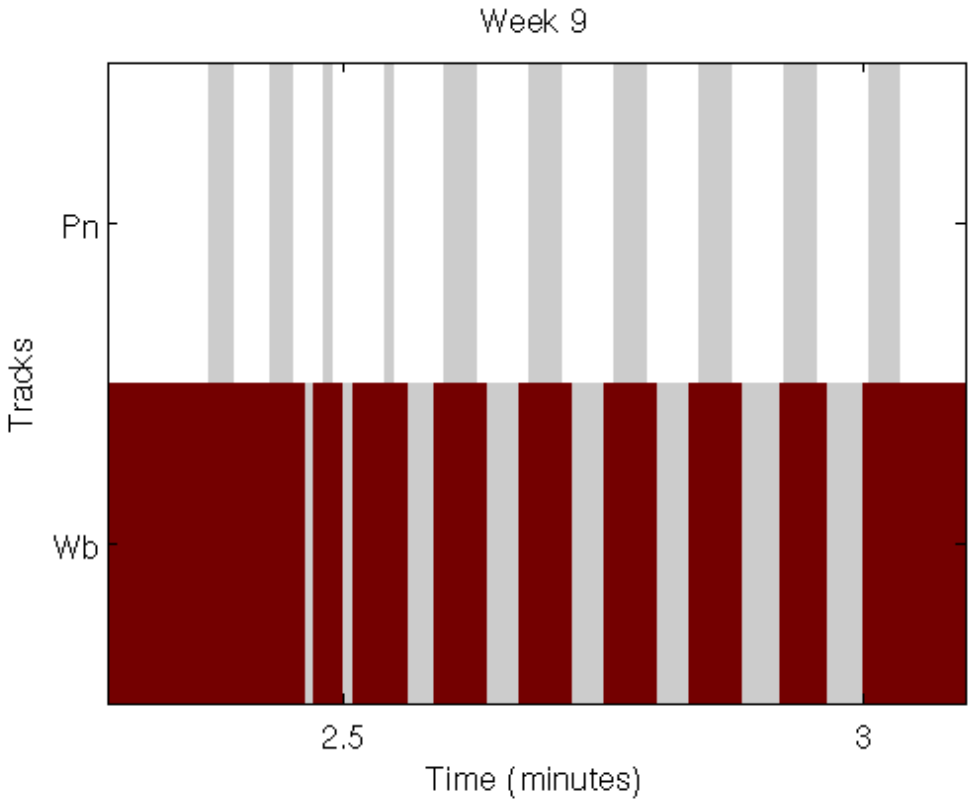


The automatic mapping identified changes in instrumental use in the first five minutes of nine simulated test sessions. For example, from week 7 to week 9 the 'patient' moved from playing very little on the drum to making use of drum and cymbal over a longer period of time. From this type of mapping we can also identify sessions in which there appears to be an element of organisation within the patient's playing; for example in week 5, between minutes 1.2 and 3.2, the extended drumming is regularly interspersed with cymbal activity.

Using this method, areas of special interest can be further investigated, for example, *Figure 6.15* shows an enlarged map of the interactive playing on the piano and woodblocks in week 9. (The episode was identified from the week 9, 1st five minute map shown in *Figure 6.14*).

Figure 6.15: Lab Test 1: Interactive detail from week 9

(Grey = no audible activity, White = piano activity, Brown = woodblock activity)



The interaction exchange between the 'therapist' and the 'patient' is clearly visible.

6.28. Field Test Recordings: Analysis of Tempo Change

Given the output of the music-silence segmentation, it was possible to directly analyse regions of interest within the clinical field test audio recordings with the aim of extracting higher level musical information. One such task was the extraction of tempo. To provide sufficient data for analysis of tempo, only those musical activity regions of at least one minute duration were considered. To enable comparisons between the performance of the therapist and the patient each channel was analysed separately and, as more than one instrument was played by the patient during the session, those associated with the patient's playing were combined into one summary visualisation.

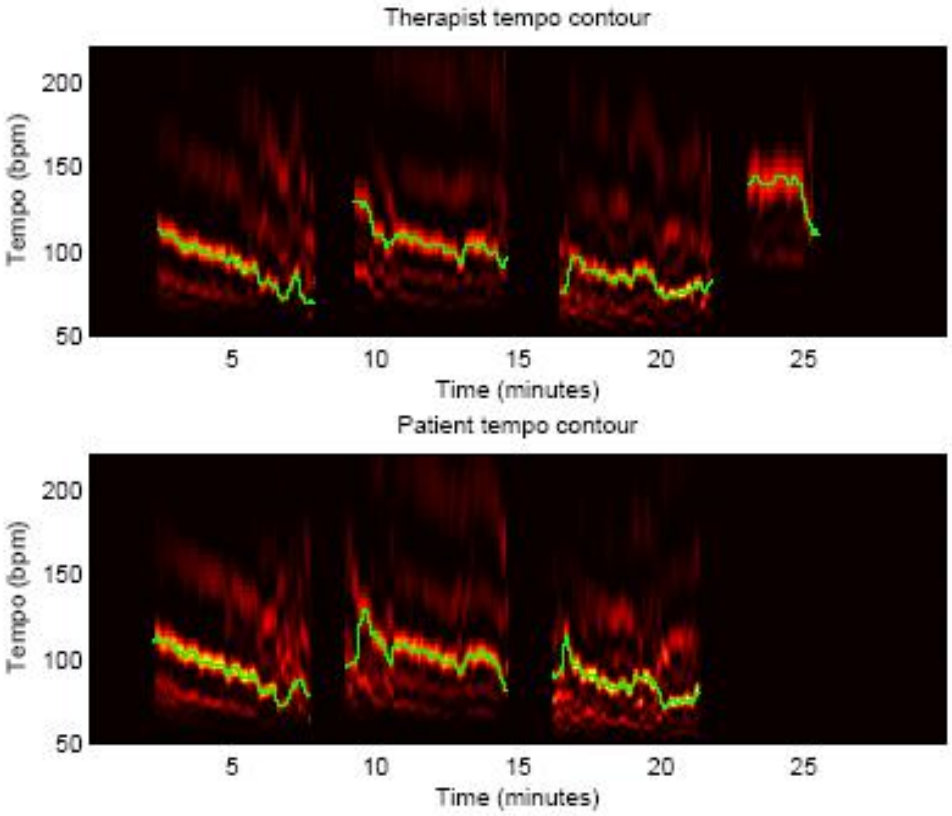
The process used for identifying and tracking the tempo of the musical performances was based on Dr Davies's previous work in rhythm analysis (Davies, 2007). For the Music Therapy Logbook investigations, Dr Davies made the following adjustments to his existing algorithm; the input to the tempo analysis program was used as the onset detection function calculated within the music-silence segmentation task. This onset detection function was split up into analysis frames across the length of each region of musical activity. Each input frame was then compared to a set of template functions covering a wide range of tempo hypotheses (50-220 beats per minute (BPM)).

The extent to which each analysis frame matched all the tempo hypotheses was stored then a best path of tempo through time was obtained using the Viterbi decoding algorithm. The resultant path represented the tempo contour.

An example of the tempo tracking is shown at *Figure 6.16*. A plot of the therapist's tempo contour is shown at the top and a plot of the patient's tempo contour is shown underneath. (The regions of musical activity for the patient, Mr B, have been combined across all instruments so that this is a summary of all of Mr B's musical activity in Week 2, considered in terms of the tempo he was using at any one point in time). In the example shown, varying depths of orange colouration show the strength of tempi at any one time. The green lines follow the strongest tempi data, and give the overall tempo contour of each player's performance. The Y axis indicates beats per minute (BPM). What is first evident is the very close connection between the two

player's tempi alterations. (Music therapists working in this style of practice are trained to accurately match a patient's tempo changes, but we also know that Mr B was keen to please his therapist and was known to comply with her music making.)

Figure 6.16:Field Tests: Tempo Contours across regions of musical activity: Mr B: Week 2 (clinical session 20)



Discussion of Tempo Tracking Results

(Readers are requested to refer to *Figure 6.12* and the tempo tracking map illustrated above to identify the audio events referred to in this section which are available to listen to in *Media Example 12*).

The tempo tracking analysis shows that the tempo of each player started faster than it ended in improvisation 1 (drum and piano) and in improvisation 2 (wood blocks and piano). There is a less obvious tempo change in improvisation 3 (metallophone and piano). In improvisation 4 (piano duet) the same tempo is maintained until a

rallantando slows the music towards the final cadence. We know from the therapist's recording report for this session that she was aiming to help Mr B slow his playing down; (to view the report please refer to Appendix 5, Mr B week 2). However, it cannot be deduced from the tempo contour analysis (*Figure 6.16*) that it was the therapist who brought this about. The two players' tempo tracks are so similar it is only possible to conclude that both are closely following each other's tempo changes.

On listening back to the session it is clear that the therapist employed a number of musical techniques to try to slow the tempo of the shared improvisations. The most marked example of this comes in the drum and piano improvisation (start point 2.14 minutes, *Media Example 12* Mr B Week 2, Instrumental Mix) when at 5 minutes into the improvisation the therapist decides to change from duple to triple time, then disturbs the flow of the music by playing off beat staccato chords. It is clear from listening to the track that these interventions were effective in slowing the pace of the improvisation. Thus, the tempo tracking analysis of this session can only be used as evidence of the success of the music therapy techniques applied, when used in conjunction with audio listening. However, the principle of automatic tempo tracking as applied to music therapy computational analysis, is proved by this example.

A number of refinements were discussed for possible further investigation; as the recognition and quantification of rhythmic patterns matched well to the therapist's second evaluation question, it was decided to investigate whether it was possible to quantify these events from the test recordings of music therapy with Mr B.

6.29. Test Recordings: Identification of Rhythmic Patterns

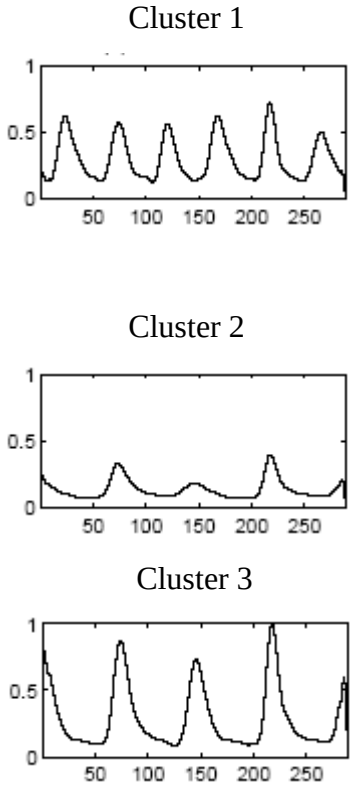
The extraction of tempo enabled further analysis to be undertaken. It was decided to extend the rhythm analysis to include the identification of beat locations (equivalent to human *foot-taps* in time to music) and use these to identify repeated rhythmic patterns in the patient's playing.

Knowledge of beat locations allows the analysis to operate in musical time; instead of analysing the music over fixed time scales the music is analysed using a beat-by-beat

approach. This is important as it enables meaningful analysis of rhythm even when the tempo varies. The beat locations were extracted using a dynamic programming algorithm (Ellis & Polliner, 2007) which matched beat positions to strong, periodic peaks (consistent with the extracted tempo contour) in the onset detection function. Given the beat positions, the onset detection function was partitioned into two-beat long windows which were centred around a single beat (i.e. half of the previous beat, the current beat, half of the subsequent beat). Each two-beat analysis frame was then time-scaled to have a fixed duration, then all frames were combined together.

In order to monitor the frequency of Mr B's persistently repeated rhythmic patterns, Dr Davies reported using the k-means clustering algorithm (Bishop, 1995) and by this means was able to isolate 3 different sets of 2 beat cluster patterns from Mr B's playing. The algorithm returned summary patterns for each of the three cluster patterns chosen. The patterns are illustrated below in *Figure 6.17*. The Y axis shows the amplitude, the X axis shows how the different 2 beat clusters are dispersed across the same time frame.

Figure 6.17: Two beat cluster patterns identified from Mr B's improvisations



It was then possible to determine the occurrences of each cluster and from this determine to what extent the occurrences were repetitive (rather than dispersed) in each of the instrumental improvisations. *Figure 6.18* shows the incidence of Mr B's 'stuck' repetitive rhythmic playing in the week 2 recording (clinical session 20).

Figure 6.18: Incidence of repetitive rhythmic playing in three improvisations Mr B. Week 2

Instrument	**Cluster 1**	**Cluster 2**	**Cluster 3**	**Stuck Rhythmic Pattern Percentage**
Drum	36.8%	**28.1%**	**35.1%**	63.2%
Wood Blocks	73.4%	14.9%	11.7%	0.0%
Metallophone	**19.8%**	**3.4%**	76.8%	23.2%

(Bold indicates Percentage of Time Patient Used 'Stuck' Rhythmic Patterns)

By checking the instrumental activity measurements for this session *(Figure 6.12)* it is clear that Mr B played the drum and metallophone for almost the same amount of time. The results shown in Figure 41 therefore indicate that computational analysis has identified on which instrument Mr B played the majority of his persistently repetitive patterning in this session. (An example of the drum patterning can be heard in *Media Example 12* Mr B Week 2, start point 2.48 minutes – 3.29 minutes.) Mr B is persisting in his beat patterning and the music therapist is fitting her music around what he does, sometimes trying to suggest changes.

The metallophone play starts with a more abstract use of the instrument; Mr B uses his beater to make glissandi up and down the instrument and the music therapist accompanies this with atonal music. Soon Mr B announces his pattern again and the therapist's music finds a tonal centre in response. (This change can be heard in *Media Example 12* Mr B Week 2, start point 16.15 minutes – 18.15).

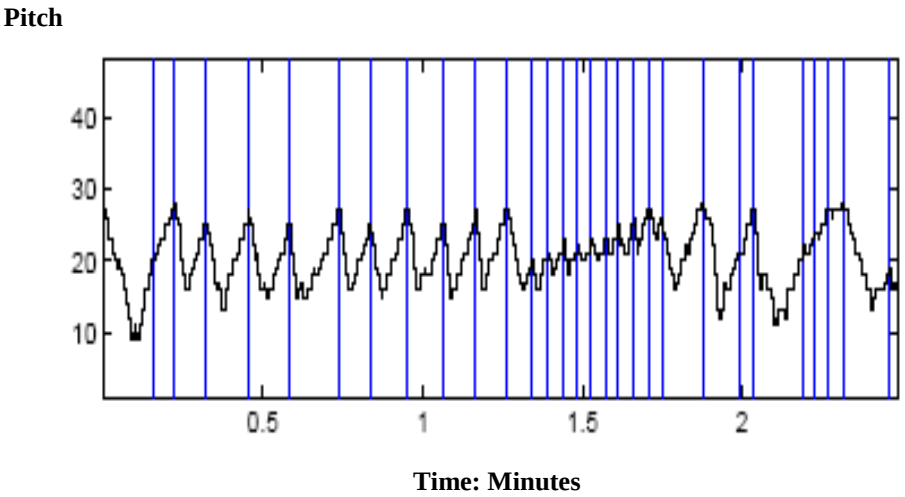
The type of computational analysis applied here only attempts to deliver data on one aspect of the music – the amount of pattern repetition used by Mr B.

6.30. Field Test Recordings: Analysis of Repeating Melodic Patterns

Most of the computational analysis tests addressed the temporal and rhythmic aspects of the music therapy recordings without any focus on harmonic and melodic structure. However, we were able to examine the extraction of pitch information in relation to the repeated patterns within the recordings and were able to identify what we referred to as *ladder events*.

Some of these were analysed from Mr B's metallophone playing. The repeated glissandi patterns often took the form of continued upward or downward movement.. Dependent on whether the patient took the treble or bass end of the instrument, we either looked for ladder-type structure from the top-down or bottom up, then discarded notes which didn't fit this pattern. *Figure 6.19* shows an example of an ladder event identified automatically by the computer:

Figure 6.19: Field Tests: Computational Analysis of Melodic Patterning on Metallophone



Once the data had been reduced in this way, it was possible to track a sequence of pitches and identify the change points to indicate the number of ladder events. Thus, quantification of such events over a series of sessions can be achieved.

6:31. Chapter 6 - Conclusion

The recording techniques used, and the signal processing applied, allowed a number of different computational analysis tests to be applied to recordings of simulated music therapy improvisations, and to recordings of live, individual music therapy sessions in a neuro-disability unit. During both sets of tests acoustic percussion instruments were played. In Lab Test 1 a MIDI piano was used, in Lab Test 2 an acoustic grand piano was used, in the clinical Field Tests a MIDI piano was used.

Two music therapists were trained to use the recording system. A music therapist researcher ran a pilot test of the system. A second therapist, who had not been party to any research meetings and was not part of the research team, tested the system in a neuro-disability unit where she was working. After a training session, the music therapist was left with the audio recording equipment and used it for routinely recording her sessions with three patients (who gave permission for the recordings to be used for the purposes of this research.)

Computational analysis tests were later applied to these recordings by a specialist music information retrieval engineer in consultation with the author. This study has focussed on the results of analysis tests which were applied to the multi-track audio recordings of the music therapy sessions with Mr B (a patient who had suffered traumatic brain injury). The results give rise to the first examples of computational analysis applied to multi-track audio recordings of live, one to one music therapy sessions. The analysis techniques focussed on identifying changes in the use of instruments over time. It was possible to measure changes in the duration of time the patient spent playing different instruments. It was possible to identify and quantify the amount of rhythmic and melodic pattern repetition in a patient with perseverative musical play. It was possible to identify changes in the tempo relationship between the two players.

The intention behind devising and applying computational analysis tests to the recordings was to match the evaluation interests of the clinical music therapist working with Mr B; thereby taking the approach that computational analysis is only meaningful if it can answer the types of questions music therapists want to ask.

Three questions informed the computational analysis tests:

- Can computational analysis identify changes in a patient's overall flexibility; for example identify how often he or she initiates an improvisation, rather than merely joins with the therapist.

- Can computational analysis deliver evidence of changes in the amount of time a patient spends repeating habitual rhythmic patterns?

- Can computational analysis identify whether the therapist's metric changes are effective, or not, in increasing a patient's tempo flexibility?

By explaining how computational analysis tests were applied to one particular music therapy session, Mr B, Week 2 (clinical session 20) the results show how different approaches to computational testing evolved in order to try to answer these questions. For example, it was possible to identify whether or not Mr B started playing before the therapist did, but it wasn't possible to know from the results of the silence- music segmentation tests whether the patient initiated the musical play; he may have been picking up signals from the therapist that couldn't be captured on the audio track.

Being able to monitor the instrumental activity of both players allowed us to gather evidence of the very close and reflective playing that was taking place, which the therapist had referred to, at the start of her involvement in the project, as Mr B's compliance with her music. Although it was not possible to deliver instrumental activity data for all of Mr B's sessions, other tests simulating the instrumental activity showed that maps could be created to show changes in instrumental use over a number of sessions and this was thought by the therapist to be particularly useful.

Tempo tracking between the players, and the identification of Mr B's rhythmic patterning was of particular relevance in relation to the evaluation questions. It was

shown possible to quantify how much of the time spent on one instrument was dedicated to repetitive patterning. Some elements of pitch identification were shown to be possible in relation to the patient's melodic playing on the metallophone, but there was insufficient time to follow up all of the research possible on this topic.

Computational tests took into account the therapist's approach to her practice. The changing musical relationship between the two players is of particular interest to those who practice the Nordoff-Robbins approach. On listening to the metallophone play, it is clear that the mood expressed by the players, particularly the music therapist, conveys something of the sadness of being stuck and the hopelessness of not being able to change.

This aspect of *knowing about* music therapy is better suited to descriptive note writing than automatic computation. However, it is argued that each monitoring method can enhance the other. By using the proposed system a therapist would be able to check whether a patient has indeed spent more time patterning in one session than another. They may want to monitor their own tempi and find out whether they are leading or following. In some therapies the therapist may feel that nothing is changing when in fact it is – or vice versa. Gathering objective evidence may help in understanding when best to encourage the repetition of musical patterns or phrases and when best to try to limit the patient's experience of this type of play; for this type of play can be used by some patients to block out the possibility of emotional expression, or the possibility of relating to the therapist through music making

In the case of Mr B's therapy, it remains uncertain whether his repetitions were linked more to his physical and neurological condition than to his emotional state. It has not been the purpose of these computational tests to try to find the answer to that question. This method of monitoring music therapy merely provides data for therapists to interpret according to their areas of interest and styles of practice.

CHAPTER 7: Music Therapy Logbook
Developing a User Interface

7.1. Introduction

The aim of this chapter is to give the reader an impression of what it would be like to review a music therapy session using the proposed Music Therapy Logbook software. This is achieved by explaining the main functions of the proposed software interface pages, then explaining how the session review page is intended to be used.

No complete software package yet exists and there are issues outstanding that need to be resolved; in particular, player identification. A further period of research and development is therefore necessary. As patient data will be stored, the software will need to contain robust storage facilities and meet the ethical requirements of a range of health management providers. This aspect requires further development.

However, the preliminary investigations described below suggest that once the final technology is successfully tested, the actions required by music therapists to operate the software will not be complex. The guiding principle has been to listen to the feedback gathered from music therapists; time and again music therapists have reported that *the software must be easy to use.*

It is not within the scope of this study to explain technical aspects related to computing or software development as this is not the author's area of expertise.
The main results of the collaborative research are therefore presented and discussed in relation to music therapist user needs. Following an initial period of page design using the paper programming method, the author engaged in a valuable collaboration with two post-graduate students previously registered at the University of York: Ms Bramwell-Dicks created power point slides (Bramwell-Dicks, 2008), Ms Lian Zhang enabled some control icons to become true elements, meaning it was possible for Ms

Zhang to activate some program functions, (Zhang, 2008, page 2). The process of collaboration was as follows: The author informed the student researchers of the general schema for the software functions she required, the students then considered the technical requirements and produced proposals for folder structure, data storage and directories. In collaboration with the author, mock up user interface pages were designed. The author presented the preliminary designs to a focus group of four music therapists working for the Northern Ireland Music Therapy Trust in Belfast. The pages were then revised. The programming required to build the framework of the software (i.e. creating functions and arranging logic links between functions) was investigated, (Zhang, 2008). *

7.2. Proposed Main Functions of Music Therapy Logbook Software

- Receive audio signals and store audio data
- Store patient profiles and session notes
- Allow audio play back
- Allow semi-automatic audio analysis
- Allow automatic audio analysis
- Allow the integration of graphs and charts into written reports

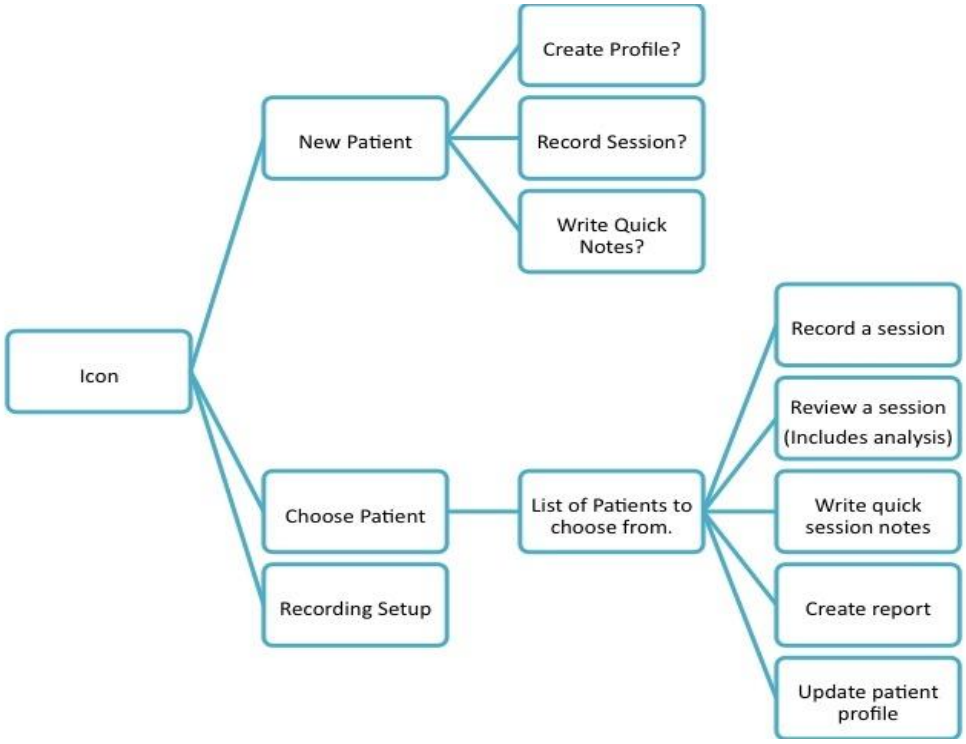
The aim of all the proposed software functions is to help music therapists evaluate their therapy sessions with individual patients, with or without the aid of the music therapy analysis features previously described. (Although video analysis has not been investigated as part of this research, it is thought likely that video storage and analysis would be a valuable future addition to the proposed functions outlined above.)

Figure 7.1 shows the proposed action flow route for the Music Therapy Logbook software. On opening the software the therapist can set up a new folder for a new patient, record a first session, and /or write quick notes. Alternatively, if music

* [The author is grateful to Ms Bramwell Dicks (2008) and Ms Lian Zhang (2008) for their permission to use and adapt illustrations from their M.Eng. and Msc.Music Technology final reports]

therapy is ongoing, the therapist selects a patient from his or her practice list, either chooses to record a new session, write session notes, review (listen back to) a previous session, review and analyse a previous session or update their patient's profile. Drawing on a combination of analysis and their personal notes the therapist can then create a report, if desired, or research their practice.

Figure 7.1: Proposed Main Software Functions Flow Chart



7.3. Introduction to Software Page Illustrations

The user choices described below support both qualitative and quantitative music therapy evaluation methods. As previously discussed, music therapists employ a variety of different methods for monitoring their work; indeed, it is likely that some employers prefer quantitative evidence whilst others are still happy to receive

subjective summaries. With this in mind it was decided to include functions that would facilitate existing evaluation methods, as well as those that are new to music therapists. For example, quickly locating a session recording whilst you are writing notes about it (because the two files know about each other) is a way of speeding up an already familiar process, whilst tagging audio events, and commanding quantification of those tagged events, is probably unfamiliar to most music therapists.

Therefore the proposed software can be used for audio recording, storing recordings and writing notes, or for higher level activities involving semi-automatic and / or automatic computational music analysis. The user is expected to choose the level of interaction with the program which best suits their interests, their evaluation questions and the time they have available for evaluation. Once confident with familiar tasks the user can later move on to less familiar activities.

This raises the need for clear and precise instructions and for a suitably designed user manual. It is expected that short training sessions would be made available in the form of Continuing Professional Development short courses.

The first step for a Music Therapy Logbook user will be to set up their recording preferences and test the recording system in their music therapy room. Once that is achieved the user can set up an evaluation folder for each of their patients.

7.4. Setting up a Folder for a New Patient

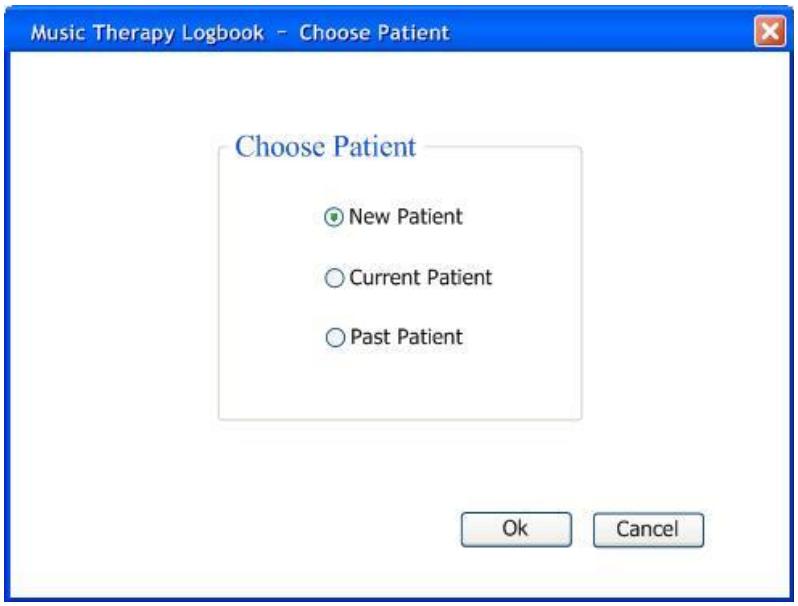
The evaluation folder is where each patient's data will be securely stored - audio recordings will be stored along with the therapist's notes and reports. Computational analysis related to the audio recordings will also be stored. However the user will not be faced with a long list of files from which to choose. The files can be hidden whilst the user negotiates a quick path towards a particular action. The following slides take the reader through the action pathway:

Figure 7.2: ***Slide 1****: Open Software*

Step 1: Double Click 'Start Up Music Therapy Logbook' button.

Like other software programs, the Music Therapy Logbook software will be easily identifiable from a program list. An icon will replace the illustrated start up button above. Slide 2 asks the therapist to select either a new patient or an existing patient:

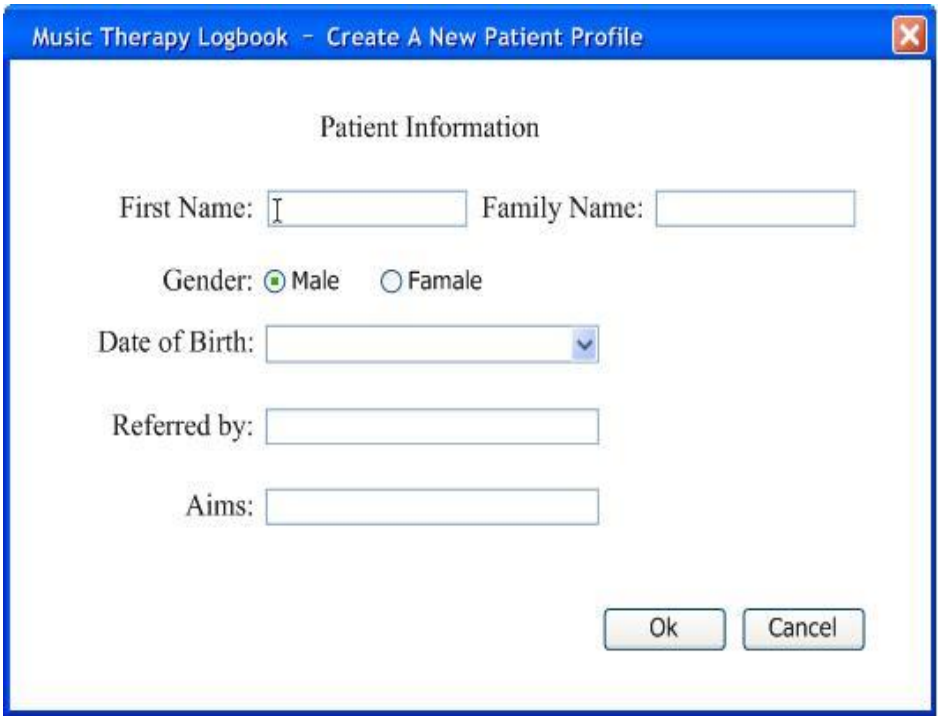
Figure 7.3: ***Slide 2****: Choose Patient*



Step 2: Choose 'New Patient' and **Click** 'Ok'.

The therapist is asked to input data to create a patient profile. The therapist can choose to select therapy aims from a pre-programmed list, or write their own brief description of the aims. For the purpose of keeping the page simple, it was decided not to request diagnostic information. However, music therapists may decide in future that they want to be able to select a diagnostic label for some of their patients and such a list can be included. By linking diagnostic information with retrieved data certain types of evaluation would be better facilitated, for example comparing uses of music by children on the autistic spectrum to those with depression.

Figure 7.4: ***Slide 3****: Create Patient Profile*



7.5. Opening a Current Patient's Folder

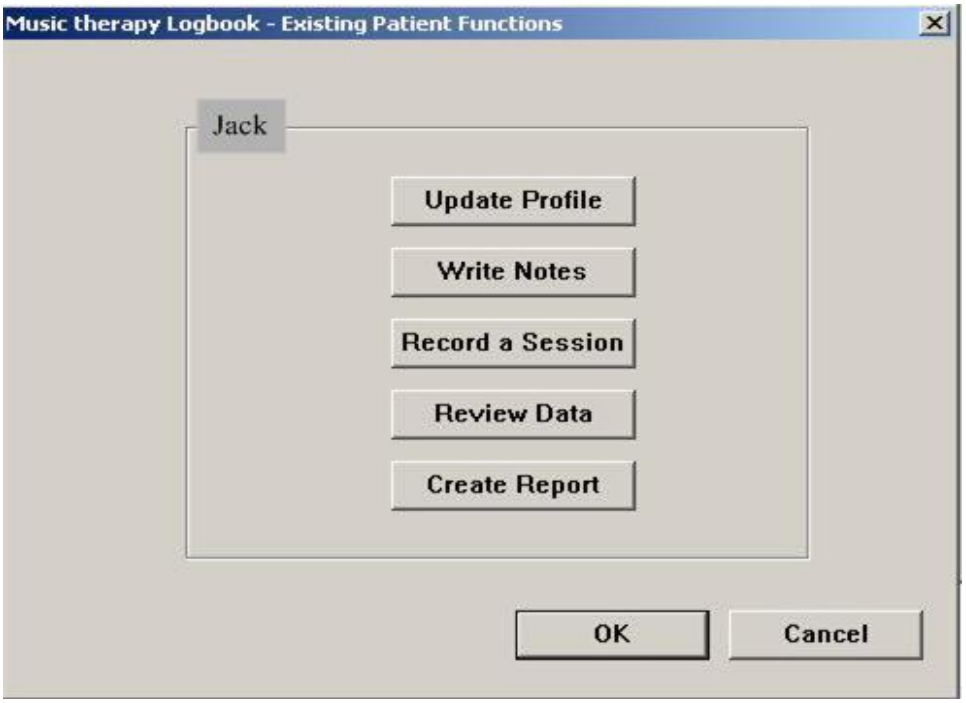
Once the therapist has set up the folder the next time they want to access it they simply follow previous steps 1 and 2 and select 'Current Patient'. A list of their patients appears:

*Figure 7.5: **Slide 4**: Choose Patient*

For example**, Choose** 'Jack' and **Click** 'Ok'

*Figure 7.6: **Slide 5**: Choose Activity*

The page opens with a list of actions. The therapist chooses how they want to work.

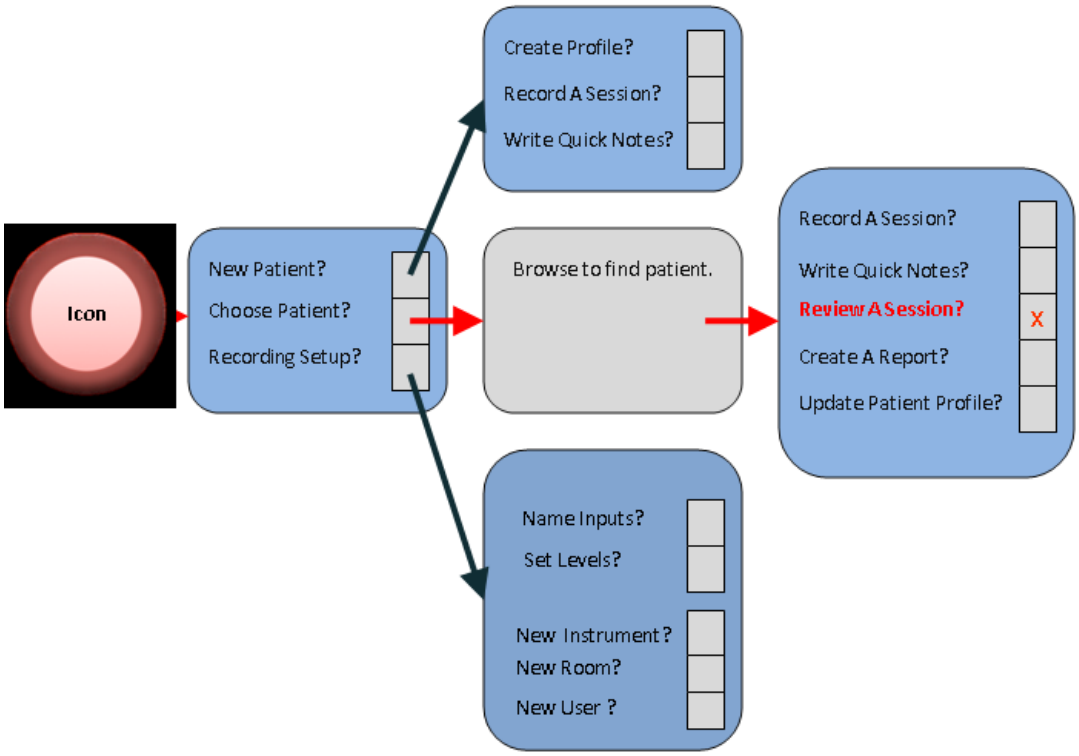


For example, **Choose** 'Review Data' and **Click** 'Ok'

7.6. Reviewing a Music Therapy Session: Overview

Figure 44 shows the route a user has taken to access the review page. The figure also illustrates the other available routes.

Figure 7.7: Interface Flow Chart



The therapist can now select which session to review from a dedicated list containing all the sessions recorded with this patient. By selecting a session to review, a review window opens. This allows access to the stored audio tracks, written notes and any computational analyses that may already have been completed. From the review window the therapist can choose to:

- Listen to the audio recording
- Tag events in the audio tracks whilst listening back
- Write notes whilst listening back
- Command semi – automatic computational analysis
- Command automatic computation analysis

7.7 Review Page: Listening Back: Option 1 'Quick Tag'

Slide 6 shows the review page. The user has selected 'Quick Tag' from the view options and has activated audio play from the playback controls (situated at the bottom on the left hand side). The view window shows that the audio track (illustrated in green) has just started playing. The quick tag audio track is an automatic mix of all instruments and voices recorded in the session.

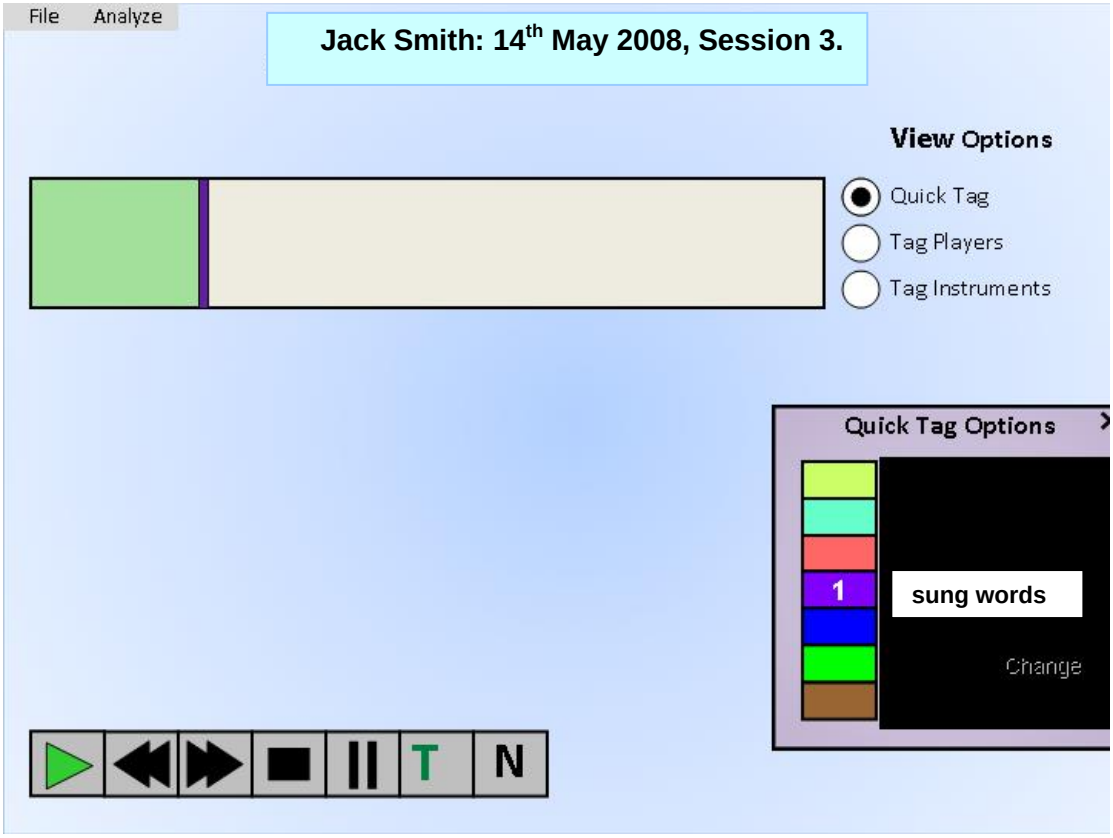
Figure 7.8: ***Slide 6****: Listen Back (with Option for Quick Tag)*

This mode is used for listening back. However, therapists can place markers (tags) to events as they listen back. The usual audio playback controls are located in the left hand lower corner; these include 'T' for tag and 'N' for notes.

The page is designed so that the therapist can select 'T' or 'N' whilst playing the audio track. This means that if a therapist hears something of interest they can tag it right away rather than having to start the audio track over again, alternatively they can write brief notes.

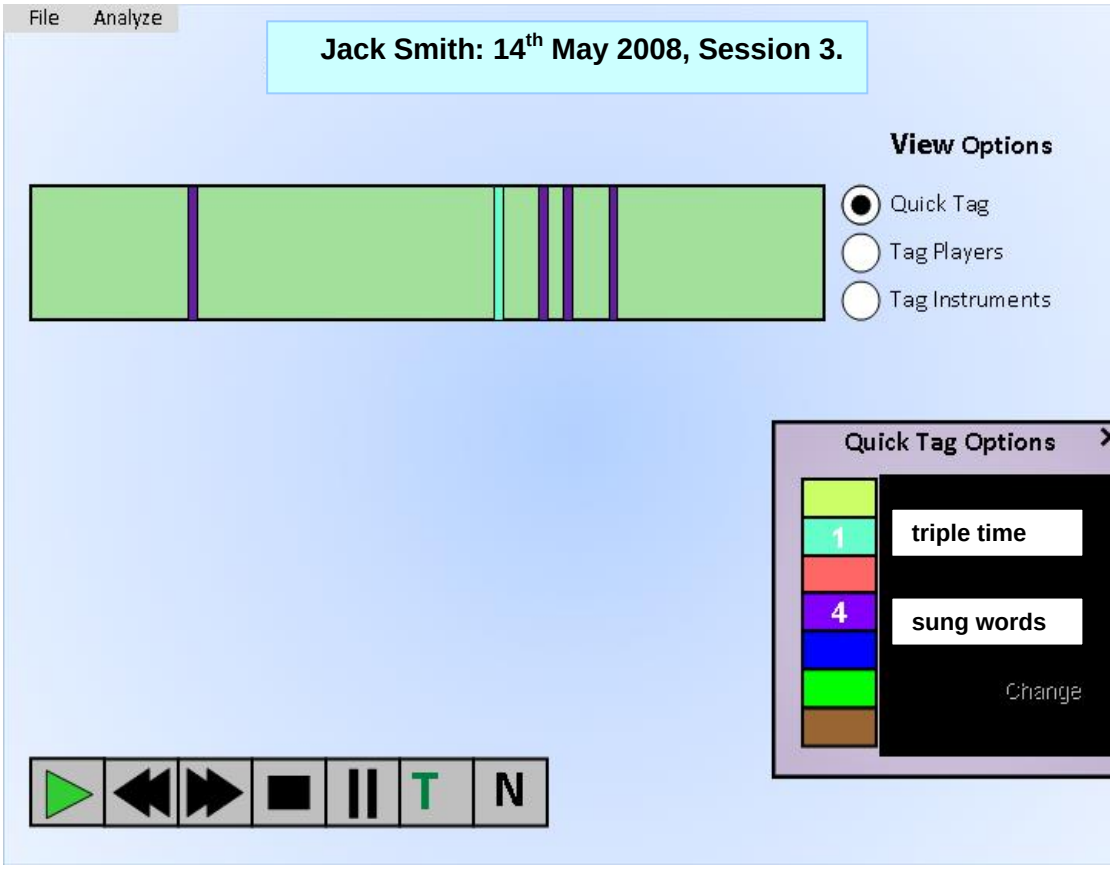
Slide 7 illustrates the review page as a therapist is listening back. On selecting ‘T’ a box appears which contains coloured squares. (The colours represent distinct event types, previously named by the therapist or chosen from a preference list). This user has set up seven event types she wants to tag. The purple button represents *sung words*. As the therapist tags an event a number is displayed, this shows the number of times this event has been tagged; in this case it is the first time the therapist has heard *sung words* (as opposed to other vocal sounds) so the tag number is 1.

Figure 7.9: ***Slide 7***



Slide 8 shows the therapist has completed listening to the audio and has accumulated five tagged events; four tags identify where words may have been sung and one tag identifies where the players tempo matched.

Figure 7.10: ***Slide 8***



7.8. Review Page: Listening Back: Option 2: 'Tag Players'

An alternative option for listening back is 'Tag Players'. Slides 9 and 10 show how the same activities can be carried out but this time there are two audio track windows so that a therapist can tag an event either associated with the patient's playing or their own. They may only want to listen back to the recording and write notes.

Music therapists want to know what effects their musical interventions have on a patient's musical play, whether or not those interventions are intentional. By saving a collection of tagged events the program can automatically quantify how often they occur, whether they are associated with other events and whether changes in the frequency or length of one event changes the frequency or length of others.

Figure 7.11: Slide 9

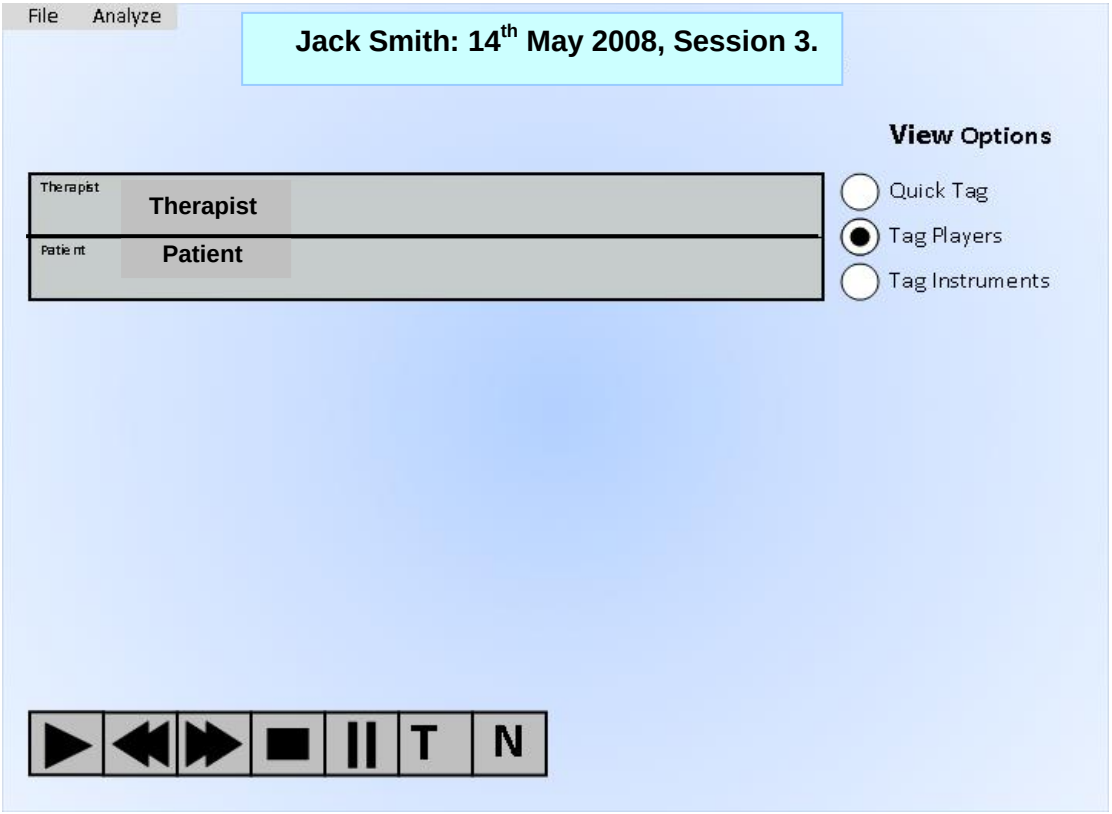
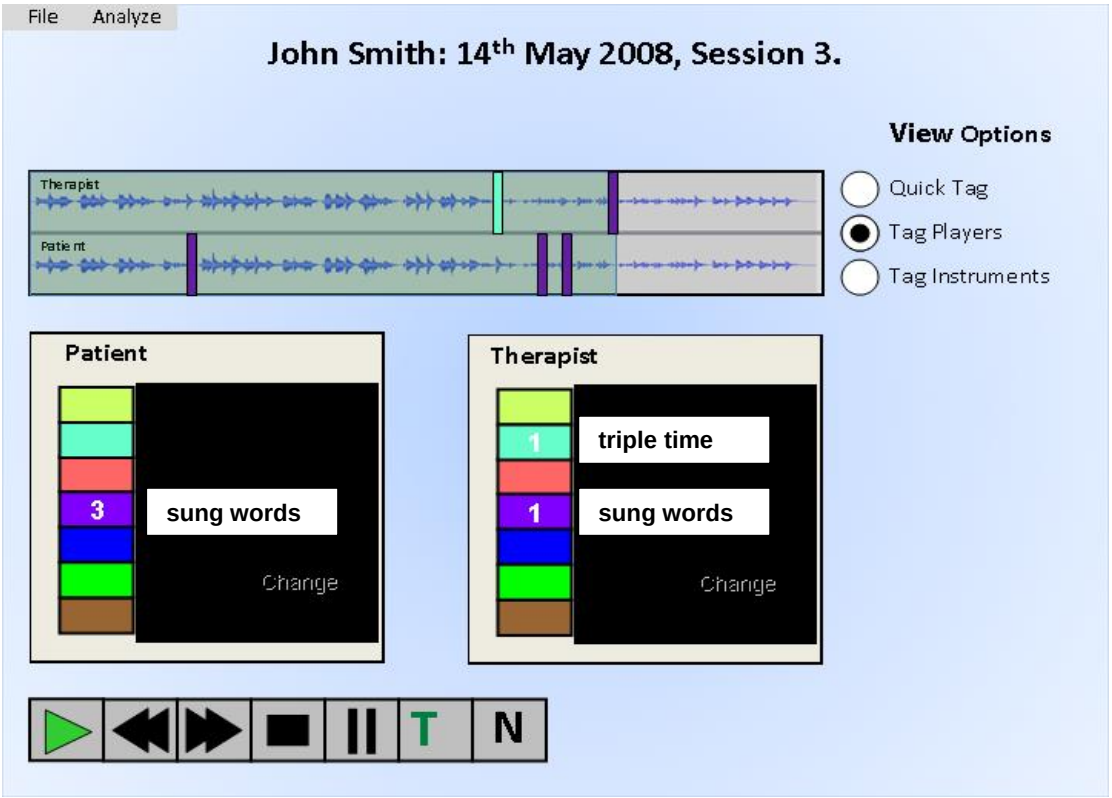


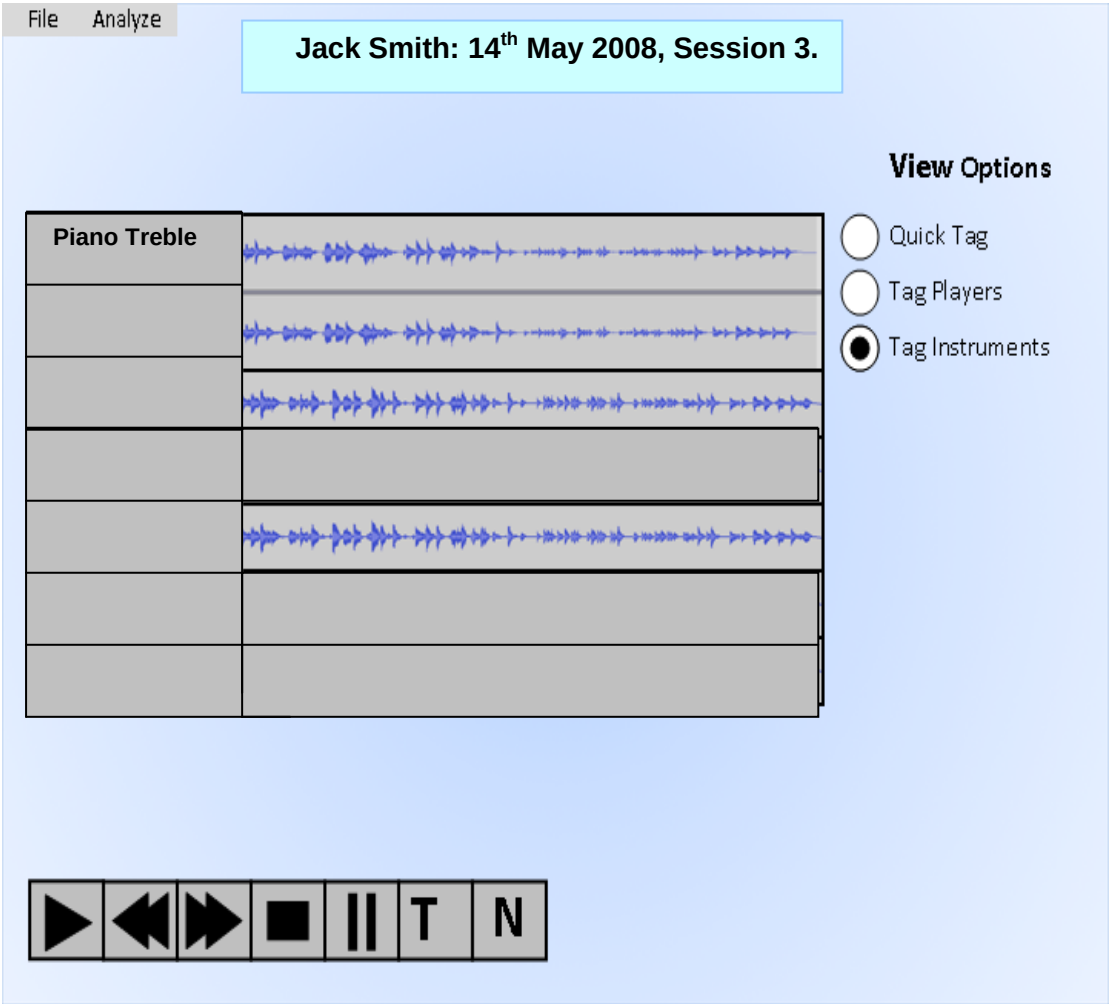
Figure 7.12: ***Slide 10***



7.9. Review Page: Listening Back: Option 3: 'Tag Instruments'

Slide 11 shows how by selecting this option for listening back, the therapist can tag events associated with particular instruments - events that the therapist may want to listen back to in more detail later, or as part of a monitoring exercise. By selecting individual track windows the therapist has the option to listen to a mix of all the instrumental tracks, to listen to one in isolation or to listen to a combination of tracks. (For example, this could be particularly useful in identifying events within a shared duet when the patient is playing a guitar and the therapist is playing a piano.)

Figure 7.13: ***Slide 11***

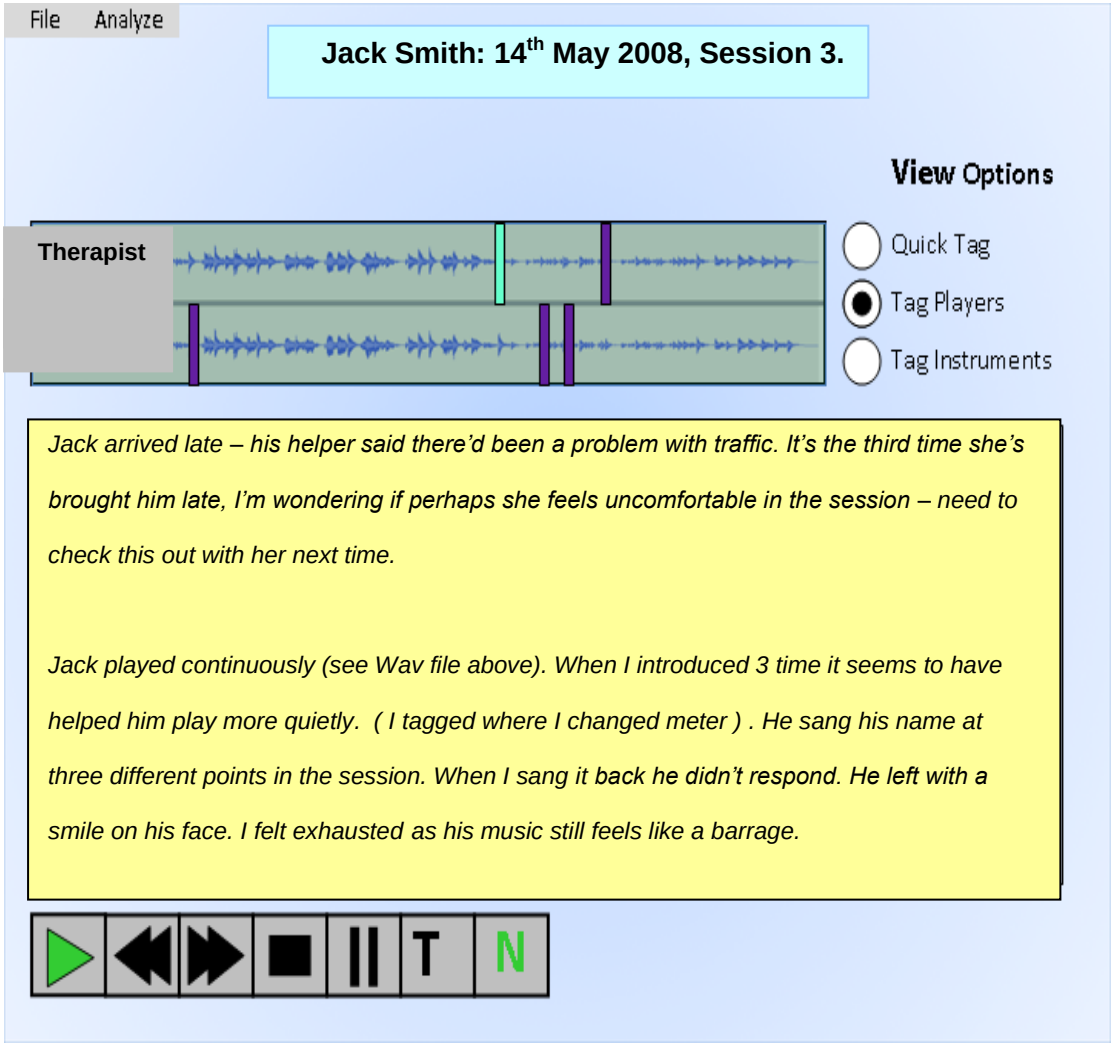


Here the normal playback controls remain in place along with the 'T' for Tag and the 'N' for write notes. (Some therapists may wish to see the wav file playing in the audio windows as illustrated in Slide 11)

7.10. Review Page: Listening Back and Writing Notes

Slide 12 shows the review page again. Here the therapist has selected Tag Players and has already listened back and tagged the key events. 'N' for note writing has been selected. The tags in the audio tracks help to remind her of key events (word singing from Jack and her decision to change from duple to triple time).

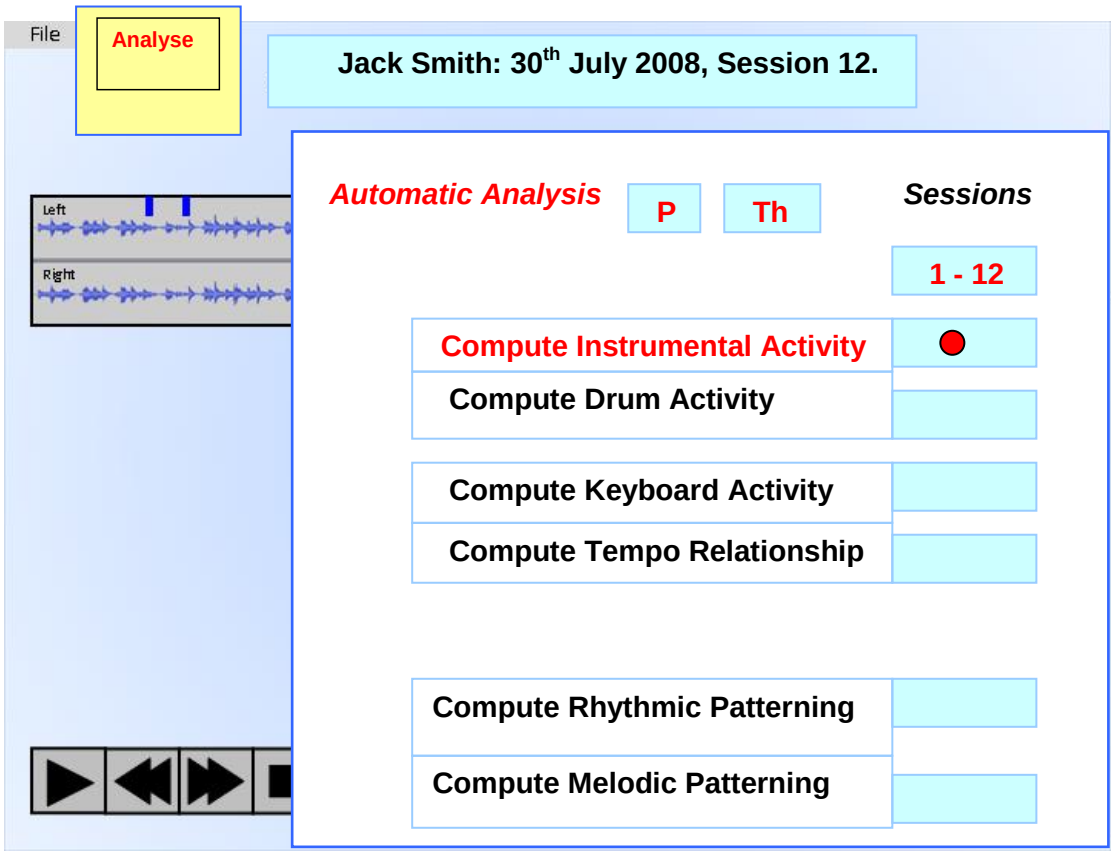
Figure 7.14: ***Slide*** *12*



7.11. Review Page: Command Analysis

After 12 sessions with Jack the therapist has to choose whether to recommend continuing with Jack or to finish the therapy over the next four weeks. She has to make this choice in relation to 10 other patients she is working with. She only has space to continue with five patients. The decision will be taken at a multi-disciplinary team meeting at which she must make recommendations. The therapist has opened Jack's review page at session 12. She has selected the 'Analyse' button at the top left hand of the page. She intends to gather evidence of his instrumental activity levels in relation to her own to help her evaluate how their musical relationship has changed over the 12 weeks. The analyze button opens up a choice list. In the end she only had time to listen back and tag events for 3 sessions so she chooses automatic analysis. She selects 'instrumental activity' then (P) for patient and (Th) for therapist (because she wants both data streams to be part of the analysis) then she tells the program which music therapy sessions to analyse by inserting 1 - 12 in the session box.

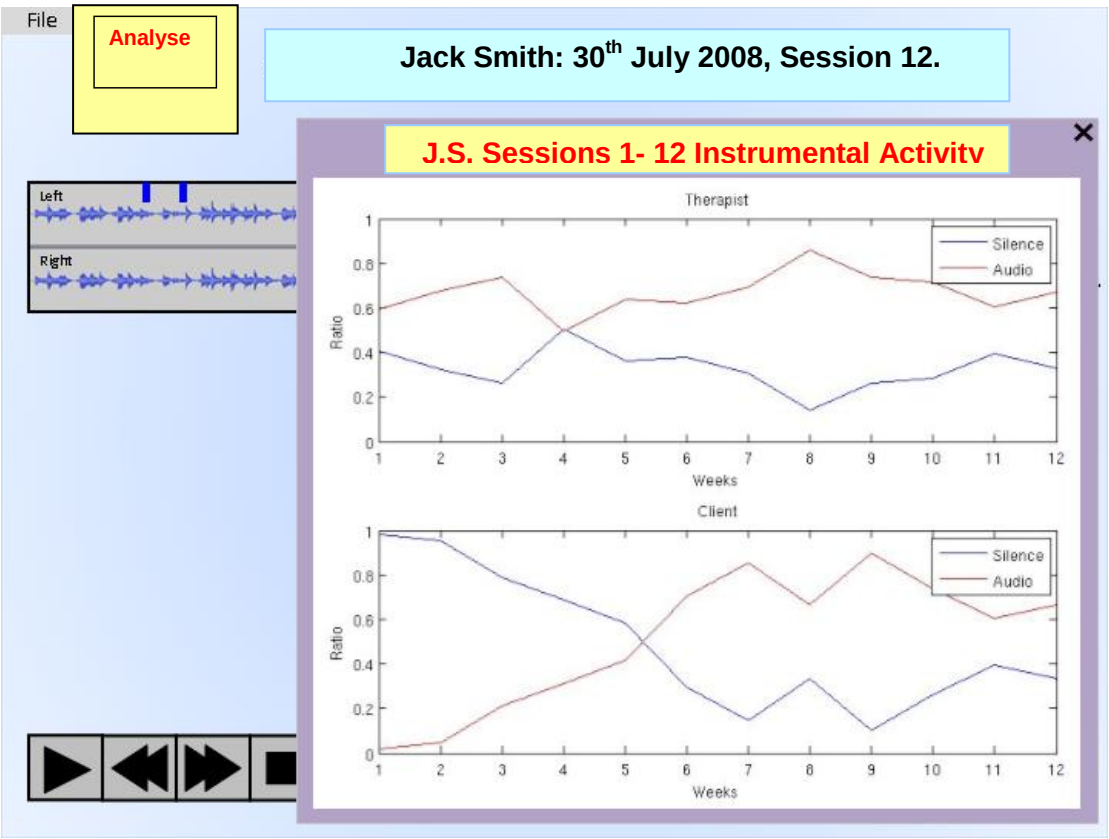
Figure 7.15: ***Slide 13***



7.12. Review Page: View Analysis

Slide 14 shows the automatic analysis the therapist has commanded. The therapist can now select the analysis graph and export it into the report she is preparing.

Figure 7.16: ***Slide 14***



N.B: The computation contained in Slide 14 is real - one of the computational tests from the simulated music therapy improvisation series presented in Chapter 6. The chart is used here merely as an example to illustrate how hypothetical patient Jack's analysis could be accessed.

7.13. Chapter 7: Discussion of Interface Development Process

Software interface design involves finding out from potential users what they want and how they are likely to react and behave in relation to any proposed interface. This part of the study focussed on investigating preliminary designs for a user friendly interface. The collaboration between the author (a music therapist), a music

technologist (Lian Zhang) and an engineer (Anna Bramwell-Davies) provided an excellent basis for investigating how the Music Therapy Logbook user process could be visually presented on screen to a user.

Robinson (2004) advises on the importance of talking to potential users, and if possible working with them, to develop a product. Given that the concept originated from a music therapist (the author) it was useful that the design process was easily initiated by the author using the paper prototype method (Snyder 2003);

> 'Paper prototyping and usability testing are common-sense techniques, and people in a variety of disciplines can benefit from using them.' (Snyder, 2003, p.17)

This enabled an initial investigation of the flow of action choices; how a particular set of choices could lead to a session review. The author wrote out interface page cards and used these to explain the basic flow of activities required for the interface pages. The engineer then moved this process forward by creating Power Point screen pages and new ideas emerged as the engineer met with the author to discuss their designs.

The author took the early stage designs to a focus group of four music therapists, working for the Northern Ireland Music Therapy Trust in Belfast. (A recent evaluation report by the Northern Ireland Education and Training Inspectorate (2007) had identified that their music therapy provision in special schools was of high quality, but that their assessments of music therapy work needed to be shared more easily with other professionals.) A three hour discussion was recorded. The therapists' expressed keen enthusiasm for a tool that can help evaluate their work in ways which provide objective evidence of positive changes in a child's use of music. The therapists were particularly keen that audio analysis should be available; they reported that the use of video was problematic, for example, because very often parents would not consent to this. Their feedback on the interface pages was generally very positive and they made a number of useful suggestions. This feedback was reported back to the technical researchers at the University of York. The interface pages were revised and the music technologist completed the preliminary investigations by programming some of the control icons (Zhang, 2008, pp.85-91)

It should be noted that the interface pages presented above depend upon music information retrieval that is either known to be possible and tested, or known to be possible and tested but not yet proven with regard to the proposed Music Therapy Logbook system. Therefore, for the purpose of clarity, it has been assumed in this chapter that the player identification system can be resolved. Clearly, this is a very important factor and it is not yet known to what degree it will be possible to resolve this issue, whether a fully automatic resolution or a semi-automatic resolution whereby the therapist helps the software to know who is playing which instrument (by, for example, typing this information into a completed recording set).

Notwithstanding the research that remains necessary before a completed working interface can be tested, it has been useful to investigate how the review page functions are intended to operate so that these preliminary investigations can drive forward the next stage of the research. This must in the first instance include taking these preliminary proposals to more music therapists in order to gather more feedback. (N.B.The automatic analysis list illustrated in Slide 13 includes only the types of automatic musical analysis that have been shown to be possible in this study. It is anticipated that further functions will be developed as and when it becomes possible to take the research and development forward.)

CONCLUSION

The study started by investigating the challenges faced by music therapists when evaluating their everyday clinical practice, in the context of evidence based health care. The study then investigated, developed and tested functions of a proposed computer aided music therapy practice evaluation system, the Music Therapy Logbook. A working prototype was tested in pre-field and field conditions. In collaboration with a computer engineer and a clinical music therapist, existing and adapted music analysis algorithms were applied to clinical field test recordings of individual music therapy sessions with patients with acquired brain injury, referred from a neuro-disability unit. The purpose of these tests was to investigate semi-automatic and automatic methods of quantifying changes in a therapist's and patient's use of music over time.

International and UK user needs surveys were conducted. The results show that music therapists are thought more likely to make use of written notes as a data source, than audio or video recordings of music therapy, when evaluating their work. This is often because of time restraints; listening back to thirty minutes of recorded music takes time. Critically analysing such a recording takes significantly more time. The study investigated how practice evaluation can therefore become detached from the core activities of music therapy; music making and/or music listening. However, the study also shows that music therapists are keen to improve and further systematise their evaluation methods.

A computer aided music therapy evaluation system does not need to measure improvement; all it need do in the first instance is capture and store data in such a way that therapists can interpret this in relation to their treatment goals. Therefore, this research has not set out to show how computer aided music therapy evaluation may or may not be able to produce a validated scale of measured improvements. The research merely investigated the feasibility of using technology to gather and organise data, and, if desired, provide quantifications of changes in a patient's and therapist's use of

music over time. Some therapists might use such a system merely for recording their sessions and reviewing those recordings in the normal way, others might use it for writing their notes, some may choose to ask questions of their music data and have a computer deliver statistical analysis of music data in relation to written notes.

There were three research aims:

> *Aim 1: To investigate the design of a prototype system that can record and quantify key aspects of a music therapy session.*
> *Aim 2: Taking into account the advice of music therapists and technologists, to identify elements of recorded data it will be useful (and possible) to quantify.*
> *Aim 3: To prove the concept of computational analysis for the purpose of music therapy evaluation*

These aims were met by a collaborative proof of concept study, as described in Chapter 6 and summarised on page 138 - 140. During the study a number of computational music analysis tests were carried out on audio recordings of individual music therapy sessions with a patient who had suffered a traumatic brain injury. (A general description of the patient's condition, the context of his care and the aims of the music therapist can be found on page 175). The results of these tests proved it was possible to quantify key aspects of a music therapy session, as evidenced in sections 6.22– 6.30, pages 176 – 192, and summarised on pages 190-192.

There were four research questions. The methods of answering the questions are outlined as follows:

> *Question 1: How do music therapists evaluate their work now?*

Question 1 was answered by means of a literature review of past and current music therapy evaluation methods, as evidenced in Chapter 3 and summarised on page 52. In addition, Chapter 4 describes the user opinion survey work conducted as part of the study. The author sought to understand the evaluation methods that music therapists currently use in the context of evidence-based health care. Four surveys were conducted (n=6, n=10, n=44, n=125) as discussed in section 4.7., on pages 108 - 111.

Three of the surveys (as evidenced on pages 59, 60, 64, 75-78) produced data on current evaluation methods in use at this time (both in the UK and internationally). The author also discussed evaluation methods with a focus group of four music therapists all working for the Northern Ireland Music Therapy Trust (as referred to on page 209).

> *Question 2: What technical possibilities and limitations are encountered when considering a computer aided evaluation tool for music therapists?*
> *Question 4: What are the technical challenges that need resolution before such a system can be made available to therapists?*

Questions 2 and 4 were answered by means of a review of music technology and computational music analysis methods, as presented in Chapter 5, discussed in section 5.11., page 132, and summarised on pages 136 - 137. Part of the study involved testing existing sound recording techniques, in particular multi-track recording techniques using radio microphone equipment, as referred to on page 168. Recording tests were successfully carried out in a laboratory setting and tested by two music therapists.

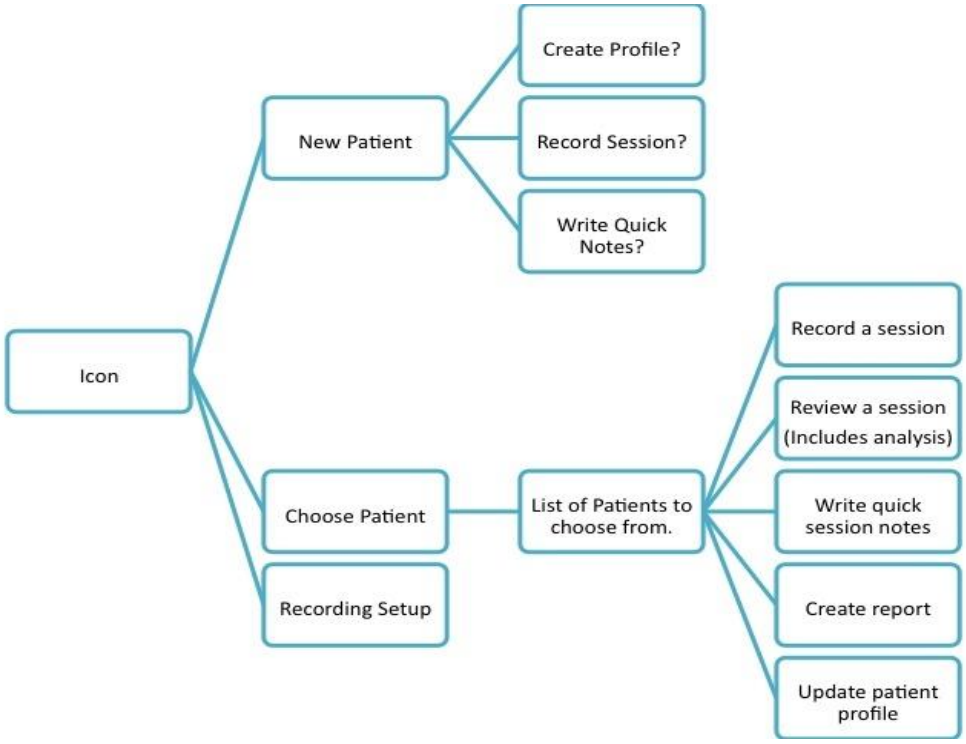
> *Question 3: Can a team of multi-disciplinary researchers investigate, assemble and test a specialist evaluation system taking into account the needs of music therapists? If so, what are the results of those tests?*

Question 3 was answered by means of the proof of concept study, referred to above, as described in Chapter 6 and summarised on page 138 – 140. The research involved collaborating with music information retrieval researchers to determine appropriate automatic and semi-automatic computational music analysis tasks to apply to the test recordings. In collaboration with the music therapist who had used the system in the field, analysis tests were applied to multi-track recordings of twelve clinical music therapy sessions.

Using music information retrieval techniques, it was possible to identify and map the duration of a patient's play on three different acoustic percussion instruments, compare this information to the therapist's play on a MIDI piano, detect which player

initiated or ended an improvisation, detect whether or not the therapist's tempo changes could be said to bring about changes in the patient's tempo, identify the duration and quantity of repetitive patterns played on three different instruments (a drum, a set of woodblocks and a metallophone) and identify melodic patterns that a patient created on a metallophone. Descriptions of the computational tests and the results of these tests are to be found on pages 176 – 192.

In addition, a user interface design concept for the proposed Music Therapy Logbook system was presented to a focus group of music therapists (as discussed in section 7.13., pages 2008 – 209). Collaborative development between three researchers (Streeter, (2008), Bramwell Davies, (2008), Zhang, (2008)) produced prototype user interface pages and diagrams of the proposed operational system, such as the one shown here and discussed in Chapter 7, page 193 -210:



The approach to interface design was based on the fact that therapists have different evaluation needs, there are different music therapy methods and different types of clinical challenges. Two main approaches to reviewing a session were explored:

- Subjective review whereby the therapist sets up *semi-automatic analysis*: event tags are named and placed by the therapist to mark events of interest in the audio tracks, the computer counts them and keeps a record for later comparison with other sessions. (This could be used to monitor the effects of a particular type of intervention.)

- Objective analysis (the therapist chooses from a list of pre-programmed analysis tasks and commands the computer to undertake quantifications of particular events. For example, quantifying the increase or decrease in the duration of a patient's joint play with a therapist across a number of sessions.

(The latter technique was tested and found to be possible).

Question 5: How likely is it that music therapists will want to use such a system in the future?

Question 5 was answered by gathering feedback from therapists on the proposed automatic and semi-automatic music therapy analysis functions to be included in the Music Therapy Logbook software, some of which were tested in this project. The user opinion studies are described and discussed in Chapter 4, and the results discussed on pages 108 – 111.

The majority of therapists who returned the survey questionnaires expressed enthusiasm for a tool that could help them keep track of changes in a patient's use of music over time. For example, 91% of UK therapists who returned Survey 4 (n=125) selected *identification and quantification of interaction episodes* as a function to be included in a future computer program proposed to help them gather evidence. Therapists from different countries, different training backgrounds and with different areas of expertise expressed excitement at the prospect of a specialist tool that can do the counting that therapists don't have time for; a tool that has the potential to help therapists systematically monitor changes in events they want to know more about.

It is therefore proposed that music therapists using different styles of practice may in future be able to make use of the same evaluation aide, thus promoting comparative research across a range of questions; for example diagnostic questions that compare the ways in which different patient populations make use of music in music therapy. One therapist commented, “Being able to analyse our work will benefit the clients and us, we will become aware of improvements we need to make”. Another reported he would use it, “…in cases that are not showing improvement, to get deeper in the music to find an answer”. One therapist rightly pointed out that the use of such a program would need to be in conjunction with therapeutic processing.

Computers have no opinions, they merely identify, organise, recall and quantify data on command, such that therapists can monitor the changes they, and their patients, want to know more about. Keeping music events central to music therapy evaluation is a way of ensuring that evidence-based practice remains musically informed.

LIST OF MEDIA EXAMPLES

[The Examples are contained in the Attached DVD]

Lab Test 1	(Dept of Music, University of York)
Media Example 1:	Simulated Improvisations 1-9 (Audio)
Media Example 11:	Testing the Equipment (Photographs)
Lab Test 2	(The Rymer Auditorium, University of York)
Media Example 2:	Conga Duet. Set 1 – Improv 3 (Audio)
Media Example 3:	Conga Duet. Set 1 – Improv 6 (Audio)
Media Example 4:	Conga Duet. Set 1 – Improv 11 (Video)
Media example 5:	Congas / Acoustic Piano. Set 2 – Improv 4 (Audio)
Media Example 6:	Congas / Acoustic Piano. Set 2 – Improv 6 (Audio)
Media Example 7:	Congas / Acoustic Piano. Set 2 – Improv 10 (Audio)
Media Example 8:	Soundbeam / Acoustic Piano. Set 4 – Improv 2 (Video)
Media Example 9:	Vocal Duet. Set 6 – Improv 1 (Audio)
Media Example 10:	Vocal Duet. Set 6 – Improv 2 (Audio)
Field Tests	(The Neuro-Disability Unit, Hawthorns Care Home)
Media Example 12:	Mr B Week 2 (Audio)
	(Side Drum, Metallophone, Woodblocks, MIDI Piano)

APPENDIX 1: SURVEY 2:

APPENDIX 1: SURVEY 2: UK Music Therapy and Neurology Group

University of York WHITE ROSE HEALTH INNOVATION PROJECT
Developing a Specialist System for Music Therapy Data Analysis with Patients with Neuro-disability

We have been awarded a research grant to design the functions of a tool: A linked recording system and computer program that will let music therapists: -

- Capture audio recordings unobtrusively -
- Analyse audio recordings objectively -
- Produce reports that, if desired, can include quantitative measurements of changes over time -

The tool is being designed to support and enhance existing evaluation procedures that music therapists already use; whether these be brief written session notes or more systematic lengthier reports. The purpose of the project is to help music therapists meet the Health Profession Council's practice standards for music therapists: In particular: -

- *Be able to observe and record clients' responses and assess the implication for diagnosis and intervention*

- *Be able to analyse and critically evaluate the information collected*

- *Be able to engage in evidence-based practice, evaluate practice systematically and participate in audit procedures*

(HPC 2008 http://www.hpc-uk.org/publications/standards/index.asp?id=39)

We aim to produce a prototype tool that can eventually be tested out with music therapists across the UK. It is important the development of this tool is led from music therapists' practical needs and perspectives – so we want to identify what music therapists would like the tool to do. To help us in this task we would like to ask you some questions to find out about: -

- The way you keep track of and evaluate your music therapy sessions now -
- Aspects of your work that you would like a computer program to quantify -

Your answers will remain completely confidential. (If you wish to remain anonymous please return the questionnaire by post)

Thank you

For more information about the White Rose Health Innovation scheme please go to:
http://www.wrhip.org

First we would like to ask questions about the types of conditions you treat with music therapy and how you evaluate the work:

1. **Which of these terms describes the conditions you treat? (please mark all squares that are relevant with an x)**

1 ☐ Multiple Sclerosis

2 ☐ Motor Neurone Disease

3 ☐ Brain Stem Infarct (locked in syndrome)

4 ☐ Parkinson's Disease

5 ☐ Multiple Systems Atrophy

6 ☐ Cerebral Palsy

7 ☐ Head Injury (mild)

8 ☐ Head Injury (severe brain injury)

9 ☐ Learning Disability……

10 ☐ Other: please name here……..

Other Mental Illnesses

2. **Do you use a published outcome measure to describe progress in music therapy?**

1 ☐ Yes - If yes, please name it here……

2 ☐ No

3. **Does your place of work have a standardised session report form that all staff must use when they work with the patient?**

1 ☐ Yes

2 ☐ No

4. Please mark in the boxes any of the methods listed below that you use to keep track of (monitor) your work

1 ☐ Writing assessment reports

2 ☐ Using musical notation to describe events from the session

3 ☐ Writing session notes to be kept on a ward

4 ☐ Writing reports for case conferences or team meetings

5 ☐ Brief notes shortly after the session describing what happened

6 ☐ Making audio recordings

7 ☐ Categorising information contained in audio recordings

8 ☐ Listening back to audio recordings and writing notes

9 ☐ Personal notes dictated to a recorder

10 ☐ Systematic note writing using the same format for each session described

11 ☐ Making video recordings

12 ☐ Watching video recordings and taking notes

13 ☐ Listening back to audio or video then writing down musical notation

14 ☐ Counting musical events in audio or video recordings

15 ☐ Playing your instrument or singing

16 ☐ Other, Please describe……

……

Now we'd like to ask you some questions about yourself

5. Which of these terms best describes you?

1 ☐ Qualified working part time

2 ☐ Qualified working full time

3 ☐ I am qualified and have worked with this client group in the past

4 ☐ I am a student working under supervision

5 ☐ I am male

6 ☐ I am female

6. How many years have you been qualified? ☐ Years

7. Which training did you do (or are you attending)?

1 ☐ Nordoff Robbins London

2 ☐ Nordoff Robbins Scotland

3 ☐ Guildhall School of Music and Drama

4 ☐ Welsh College of Music and Drama

5 ☐ Roehampton Institute Surrey University

6 ☐ University of the West of England

7 ☐ Anglia Ruskin University

8 ☐ A course not held in the UK.

[Question 8 was crossed out by hand on the original questionnaire. This is because the same question had been written in twice – once under Question 8 and once under Question 10. The original numbering remains the same in this document. Therefore there is no Question 8]

9. Now we want to ask about how you might feel letting a computer program help you gather, organise and display data from recordings of music therapy sessions

Please indicate to what extent you agree with each of these statements:

1 is the highest level of agreement and 5 is the lowest:

		1	2	3	4	5	
i) I feel interested	(agree)	☐	☐	☐	☐	☐	(disagree)
ii) I feel concerned	(agree)	☐	☐	☐	☐	☐	(disagree)
iii) I would like it if it could help me make judgements about clinical progress	(agree)	☐	☐	☐	☐	☐	(disagree)
iv) I feel positive about a tool that could help me justify the maintenance and development of music therapy services	(agree)	☐	☐	☐	☐	☐	(disagree)
v) I don't like working at a computer screen	(agree)	☐	☐	☐	☐	☐	(disagree)
vi) I'd like it to be easy to use	(agree)	☐	☐	☐	☐	☐	(disagree)
vii) I don't often make recordings of sessions so I wouldn't have much use for this	(agree)	☐	☐	☐	☐	☐	(disagree)
viii) I prefer recording sessions using video rather than audio	(agree)	☐	☐	☐	☐	☐	(disagree)
xi) If I had time I'd like to try out a program like this	(agree)	☐	☐	☐	☐	☐	(disagree)

10. Do you have access to a computer at work?

1 ☐ YES

2 ☐ NO

11. Please mark on the line how often you use it at work in an average working week

never 0----------▼----------100 each day I work
50

12. For personal enjoyment do you like listening to music on an iPod or similar device?

1 ☐ YES 2 ☐ NO

Now we are going to describe some of the things this tool might be able to do in the future:

13. ***Imagine a computer program that could link dated session notes to dated audio recordings because it allowed you to store both - you could ask the program to instantaneously quantify information - you could listen back and tag interesting events whilst writing notes, so you could listen back to them later on (like CD tracks). The following scenario gives an idea of the sorts of tasks you might use the program for:***

> *I am writing a report for a case conference and I have to see the patient for a session later on in the day. I want to bring the team's attention to changes in my patient's ability to sustain his playing because at the start he only wanted/was able to do this for less than 30 seconds. He didn't seem interested in anything. I think his attention is more sustained now but I want to check it out. Show me a graph mapping the increase or decrease in the duration of his playing episodes across sessions 1 to 10. Copy this graph into my report. Now quantify the duration of the most sustained episode. Well I was right but the increase is more significant than I thought. I'm going to be seeing the patient later and I want to listen back to the part of last week's session when we played the bells together. OK that was interesting. But I can see from the notes I wrote that the patient expressed sadness towards the end of the session – I'd forgotten that - I can't remember what I was playing at the time but I remember it seemed to support him. He turned his head to look at me. I am going to type the word 'sadness' – now find me the section of music that matches that word and play it back to me. No that wasn't the bit I meant, please do it again – OK that's it. I think I'll download that extract onto my mp3 player to listen back to after lunch. I don't want to forget that theme because I might want to re-introduce it. It seemed to really support his feelings.*

If you had access to a tool like this please mark on the line how likely you would be to use it:

unlikely 0----------▼----------100 likely
50

If you marked towards the 'likely' end of the line please go to question no 15 on the next page. If you marked towards the 'unlikely' end then please answer question 14:

14. Please tick any boxes that closely match your opinions:

I would be unlikely to use a program like this because:

1 ☐ I already evaluate my work very effectively so I wouldn't need this tool

2 ☐ I don't like using computers

3 ☐ I prefer recording with video

4 ☐ I wouldn't have time

5 ☐ I don't think I'd be able to learn how to use the program

6 ☐ My clients wouldn't want me to record their sessions

7 ☐ I don't record sessions because I feel it breaks confidentiality

8 ☐ I don't record audio because it inhibits my improvisation

15. You may have suggestions you'd like us to know about - please write in the box below - all comments are welcome. There may be things you feel are important that we haven't covered – all comments are also welcome

Many thanks for taking the time to fill this in.

Please return to

APPENDIX 2: SURVEY 3

APPENDIX 2: SURVEY 3 International Neurology Group

University of York WHITE ROSE HEALTH INNOVATION PROJECT
Developing a Specialist System for Music Therapy Data Analysis
http://www.musictherapylogbook.com

We have been awarded a research grant to design the functions of a prototype tool: A linked recording system and computer program that will let music therapists: -

- Capture audio recordings unobtrusively -
- Analyse audio recordings objectively -
- Produce reports that, if desired, can include quantitative measurements of changes over time -

The tool is being designed to support and enhance existing evaluation procedures that music therapists already use; whether these be brief written session notes or more systematic lengthier reports. The purpose of the project is to help music therapists meet the Health Profession Council's practice standards for music therapists: In particular: -

- *Be able to observe and record clients' responses and assess the implication for diagnosis and intervention*

- *Be able to analyse and critically evaluate the information collected*

- *Be able to engage in evidence-based practice, evaluate practice systematically and participate in audit procedures*

(HPC 2008 http://www.hpc-uk.org/publications/standards/index.asp?id=39)

We aim to produce a prototype tool that can be tested out with music therapists working in clinical settings. It is important the development of this tool is led from music therapists' practical needs and perspectives – so we want to identify what music therapists would like the tool to do. To help us in this task we would like to ask you some questions to find out about: -

- The way you keep track of and evaluate your music therapy sessions now -
- What you would like a music therapy analysis program to do

Your answers will remain completely confidential. (If you wish to remain anonymous please return the questionnaire by post)

Thank you

For more information about the White Rose Health Innovation scheme please go to:
http://www.wrhip.org

First we would like to ask questions about the types of conditions you treat with music therapy and how you evaluate the work:

4. Which of these terms describes the conditions you treat? (please mark all squares that are relevant with an x)

1 ☐ Multiple Sclerosis

2 ☐ Motor Neurone Disease

3 ☐ Brain Stem Infarct (locked in syndrome)

4 ☐ Parkinson's Disease

5 ☐ Huntingdon's Disease

6 ☐ Cerebral Palsy

7 ☐ Acquired Head Injury

8 ☐ Autistic Spectrum disorders

9 ☐ Other Learning Disabilities — Please name:

10 ☐ Mental illnesses that affect young people — Please name:

11 ☐ Other Mental Illnesses — Please name:

5. Do you use a published outcome measure to describe progress in music therapy?

1 ☐ Yes - If yes: - Please name it here:

2 ☐ No

6. Does your place of work have a standardised session report form that all staff are asked to use when they work with a patient or client?

1 ☐ Yes

2 ☐ No

4. Please mark in the boxes any of the methods listed below that you use to keep track of (monitor) your work

1 ☐ Writing music therapy assessment reports

2 ☐ Using musical notation to describe events from the session

3 ☐ Writing session notes to be kept on a ward

4 ☐ Writing reports for case conferences or team meetings

5 ☐ Brief notes shortly after the session describing what happened

6 ☐ Recording the session with audio equipment

7 ☐ Listening back to audio recordings and writing notes

8 ☐ Categorising information contained in audio recordings

9 ☐ Recording the session using video equipment

10 ☐ Watching video recordings and taking notes

11 ☐ Categorising information contained in video recordings

12 ☐ Listening back to audio or video then writing down musical notation

13 ☐ Counting musical events in audio or video recordings

14 ☐ Systematic note writing using the same format for each session described

15 ☐ Playing your instrument or singing

16 ☐ Other

If you have chosen 'other' please describe the other methods you use here:

Now we'd like to ask you some questions about yourself

5. Which of these terms best describes you?

1 ☐ Qualified working part time

2 ☐ Qualified working full time

3 ☐ I am qualified and have worked as a music therapist in the past

4 ☐ I am a student working under supervision

5 ☐ I am male

6 ☐ I am female

6. How many years have you been qualified? ☐ Years

7. Which training did you do (or are you attending)?

1 ☐ Nordoff Robbins London

2 ☐ Nordoff Robbins Scotland

3 ☐ Guildhall School of Music and Drama

4 ☐ Welsh College of Music and Drama

5 ☐ Roehampton Institute Surrey University

6 ☐ University of the West of England

7 ☐ Anglia Ruskin University

8 ☐ A course not held in the UK. Please name the country and course in this box:

☐

8. Now we want to ask about how you might feel letting a computer program help you gather, organise and display data from recordings of music therapy sessions

Please indicate to what extent you agree with each of these statements:

1 is the highest level of agreement and 5 is the lowest:

		1	2	3	4	5	
i) I feel interested	(agree)	☐	☐	☐	☐	☐	(disagree)
ii) I feel concerned	(agree)	☐	☐	☐	☐	☐	(disagree)
iii) I would like it if it could help me make judgements about clinical progress	(agree)	☐	☐	☐	☐	☐	(disagree)
iv) I feel positive about a tool that could help me justify the maintenance and development of music therapy services	(agree)	☐	☐	☐	☐	☐	(disagree)
v) I don't like working at a computer screen	(agree)	☐	☐	☐	☐	☐	(disagree)
vi) I'd like it to be easy to use	(agree)	☐	☐	☐	☐	☐	(disagree)
vii) I don't often make recordings of sessions so I wouldn't have much use for this	(agree)	☐	☐	☐	☐	☐	(disagree)
viii) I prefer recording sessions using video rather than audio	(agree)	☐	☐	☐	☐	☐	(disagree)
xi) If I had time I'd like to try out a program like this	(agree)	☐	☐	☐	☐	☐	(disagree)

9. Do you have access to a computer at work?

1 ☐ YES

2 ☐ NO

10. Please mark on the line how often you use it at work in an average working week

never 0----------▼----------100 each day I work

50

11. For personal enjoyment do you like listening to music on an iPod or similar device?

1 ☐ YES 2 ☐ NO

Now we are going to describe some of the things this tool might be able to do in the future:

12. *Imagine a computer program that could link dated session notes to dated audio recordings because it allowed you to store both - you could ask the program to instantaneously quantify information - you could listen back and tag interesting events whilst writing notes, so you could listen back to them later on (like CD tracks). The following scenario gives an idea of the sorts of tasks you might use the program for:*

> *I am writing a report for a case conference and I have to see the patient for a session later on in the day. I want to bring the team's attention to changes in my patient's ability to sustain his playing because at the start he only wanted/was able to do this for less than 30 seconds. He didn't seem interested in anything. I think his attention is more sustained now but I want to check it out. Show me a graph mapping the increase or decrease in the duration of his playing episodes across sessions 1 to 10. Copy this graph into my report. Now quantify the duration of the most sustained episode. Well I was right but the increase is more significant than I thought. I'm going to be seeing the patient later and I want to listen back to the part of last week's session when we played the bells together. OK that was interesting. But I can see from the notes I wrote that the patient expressed sadness towards the end of the session – I'd forgotten that - I can't remember what I was playing at the time but I remember it seemed to support him. He turned his head to look at me. I am going to type the word 'sadness' – now find me the section of music that matches that word and play it back to me. No that wasn't the bit I meant, please do it again – OK that's it. I think I'll download that extract onto my mp3 player to listen back to after lunch. I don't want to forget that theme because I might want to re-introduce it. It seemed to really support his feelings.*

If you had access to a tool like this please mark on the line how likely you would be to use it:

unlikely 0----------▼----------100 likely

50

If you marked towards the 'likely' end of the line please go to question no 14 on the next page.
If you marked towards the 'unlikely' end then please answer question 13:

13. Please tick any boxes that closely match your opinions:

I would be unlikely to use a program like this because:

1 ☐ I already evaluate my work very effectively so I wouldn't need this tool

2 ☐ I don't like using computers

3 ☐ I prefer recording with video

4 ☐ I wouldn't have time

5 ☐ I don't think I'd be able to learn how to use the program

6 ☐ My clients wouldn't want me to record their sessions

7 ☐ I don't record sessions because I feel it breaks confidentiality

8 ☐ I don't record audio because it inhibits my improvisation

14. Now we'd like to know how you feel about letting a computer program help you evaluate a patient's progress. We'd like you to rate some 'progress functions' *in terms of their usefulness* in helping you evaluate individual music therapy with hypothetical patient 'Jo'.

Please read the following description of 'Jo' before answering question 14.

> *'Jo' had a stroke 3 months ago. She is 46, married with a young daughter and works in a radio station. She has lost most of her expressive speech and is in a wheel chair. She can indicate 'yes' and 'no'. Her speech is beginning to recover and she is receiving physiotherapy.*

Imagine you've recorded 10 individual sessions with Jo and you've downloaded these recordings into your computer. Now you want the computer to do some objective analysis for you based on what it can measure and quantify.

Jo's preferred instrument is the conga drums.

Here is a list of basic progress functions. How useful would it be if the program could:

i) Measure the duration of each session ?

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

ii) Measure the amount of silence in each session?

1 is the highest level of agreement and 5 is the lowest:

1 2 3 4 5

(Very useful) ☐ ☐ ☐ ☐ ☐ (Never useful)

iii) Quantify (count) the number of times Jo made vocal sounds

1 is the highest level of agreement and 5 is the lowest:

1 2 3 4 5

(Very useful) ☐ ☐ ☐ ☐ ☐ (Never useful)

iv) Measure the amount of time Jo spent playing the conga in each session:

1 is the highest level of agreement and 5 is the lowest :

1 2 3 4 5

(Very useful) ☐ ☐ ☐ ☐ ☐ (Never useful)

v) Display a diagram that describes the increase or decrease in the amount of time Jo spent playing conga over all 10 sessions.

1 is the highest level of agreement and 5 is the lowest :

1 2 3 4 5

(Very useful) ☐ ☐ ☐ ☐ ☐ (Never useful

vi) Identify the most sustained passage of Jo's conga playing and identify which session this occurred in.

1 is the highest level of agreement and 5 is the lowest:

1 2 3 4 5

(Very useful) ☐ ☐ ☐ ☐ ☐ (Never useful)

viii) Quantify the amount of time Jo spent singing words in each session

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

ix) Please describe any other 'progress functions' you think would be useful:

15. Lets imagine Jo continues with music therapy, you want to make sure you are delivering the music therapy as effectively as possible: We'd like to know what you want the computer program to do (if anything) to help you monitor the way you are working with Jo. We'd like you to rate some 'process functions' *in terms of their usefulness* in helping you monitor the process of music therapy with Jo, whether what you are doing is having a beneficial effect

Here is a list of basic process functions. They are designed to help you monitor the therapy over time. How useful would it be if the program could:

i) Let the therapist interact with the audio tracks by letting the therapist place and name markers when listening back to recordings. When a particularly important event happens the therapist would tag it by pressing a key on the computer keyboard. (This is so the program can compare the increase or decrease of these named events across a number of sessions and display this data as a graph.)

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

ii) For each recorded session measure the amount of time the therapist plays instruments as compared with the amount of time the patient spends playing instruments. Show this as a ratio e.g.; 2:1 (therapist sounds twice as often as patient). For a series of sessions show the data in a graph that maps the change in activity levels for both of them over time.

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

iii) Identify changes in patient and therapist musical dynamic range. For example in session 2 the patient plays at ff constantly whilst the therapist plays at mf. By session 6 the relationship between them has changed, the patient is playing for most of the time at mf and the therapist is playing at mp.

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

iv) Show the correlation between the therapist's tempo and the patient's tempo across one whole session - how closely do their tempos match or differ? Compare this tempo correlation with those from other recorded sessions with the same patient.

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

v) Let the therapist hear the patient's playing separately from their own playing E.g., in a drum and piano improvisation, when the therapist is playing the piano, let the therapist listen back to the drum track without hearing the piano track.

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

vi) The computer plays an extract the therapist has previously tagged as interesting and the therapist listens back:

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

vii) The computer plays back a recorded session whilst the therapist listens and types notes. The notes are automatically date stamped and stored with the date stamped recording.

1 is the highest level of agreement and 5 is the lowest:

	1	2	3	4	5	
(Very useful)	☐	☐	☐	☐	☐	(Never useful)

viii) Please describe any other process functions you think would be useful:

16. You may have feedback you'd like us to know about - please write in the box below. There may be things you feel are important that we haven't covered - all comments are welcome:

17. Would you like to collaborate with this research in the future?

1 ☐ YES

2 ☐ NO

If yes, please tell us how you want to collaborate and write your contact details in this box.

Thank you for taking the time to fill this in.

APPENDIX 3: Survey 4

APPENDIX 3: Survey 4
(As Accessed by Members of the Association of Professional Music Therapists)

Page 1

Dear Music Therapist,

At the University of York we have been researching the development of a specialist computer program to help music therapists monitor their practice in health and special education settings. The computer program is being developed to extract measurements of changes in a patient's and therapist's use of music over time (from audio recordings) of one to one music therapy sessions. Video analysis is also under consideration.

The purpose of this one page questionnaire is to ask your opinions on some of the computer program's potential functions and to understand more about music therapists attitudes - why you may or may not be likely to use such a program in the future. It is very important to gather as many opinions as possible on what music therapists would like to have included in such a computer program, and whether indeed they would be likely to use such a system in
future.

The results of the survey will be included in a presentation to be given at the European Congress in Cadiz in May 2010. I would be very grateful if you could take five minutes to complete the survey.

Thank you,

Page 2

There are two questions in the survey but there are a number of statements we want you to consider as answers. Please take a moment to click as many statements as match to your opinions.

QUESTION 1. You are asked to evaluate how effective your work has been with a client seen for individual music therapy over a ten week period. Imagine you have recorded each of the weekly sessions on a specially designed system that allows an ordinary computer to store your recordings. Which of these functions (if any) would you want included in a computer program, designed to help you extract objective data about the client's changing use of music over the ten weeks?

Measure changes in the client's use of musical dynamics.

Quantify any increase or decrease in the client's non verbal singing.

Identify and measure interactive episodes between the therapist and client (episodes when they are responding to each other by imitating each other's sounds).

Measure changes in the amount of time the client spent singing words.

Identify changes in the tempo of a client's percussion playing in relation to that of the therapist.

Create a diagram comparing how much time the client spent playing each instrument in each session.

Compare the amount of session time the therapist used for making sounds as compared with the client.

Create a diagram which maps the amount of time the client spent using instruments and voice over the whole course of therapy.

Identify repeated musical patterns or phrases and measure changes in their occurrence.

Measure changes in the amount of silence.

Other

Other (please specify)

Page 3

QUESTION 2: Music therapists sometimes make audio recordings of music therapy sessions with individual patients. If an affordable system were available that could help you analyse your recordings and quantify changes in the duration of playing and type of playing that you and your patients create together, would you use it? Please select any statements that match your opinions.

I would not use it because I rarely record my sessions

If I had time I would use it.

I would use it if it could help me gather objective data.

I don't know.

I would use it if I could easily copy into my reports diagrams illustrating changes in a client's use of music over time.

I would not use it unless there were adequate training.

I would use it because it would help me research my work.

I would use it if it could deliver evidence of changes in the patient's music making that match to an improvement in the patient's condition, for example a decrease in obsessional playing.

I would not use a computer program to help me evaluate my work because the program would not be able to monitor changes in emotional relationship

Other

Other (please specify)

APPENDIX 4:

Permission to Use Clinical Field Test Recordings For The Purposes of This Research

THE HAWTHORNS
BARCHESTER HEALTHCARE

The Hawthorns Care Centre
O'Neill Drive
North Blunts
Peterlee
Co Durham
SR8 5UP

Tel: 0191 587 1251
Fax: 0191 586 6779

Email: hawthorns@barchester.com
Web: www.barchester.com

19 August 2010

To whom it may concern

Regarding Music therapy research by Ms. Elaine Streeter involving extracts from music therapy sessions given by Ms. Janet Graham at the Neurological Rehabilitation Unit, The Hawthorns Care Centre, O'Neill Drive, North Blunts, Peterlee, Co. Durham, SR8 5UQ.

This is to confirm that Ms. Elaine Streeter was given ethical clearance for recorded extracts from three patients' music therapy sessions to be used in her research. All three clients gave written consent for their sessions to be recorded. As Manager of the Neurological Rehabilitation Unit, I agreed for recordings to be made and included in Ms. Streeter's research.

Simon Richell
Head of Neuro-Rehabilitation Unit

APPENDIX 5:

Music Therapy Field Test Recording Session Reports

Clinical Music Therapy Field Test Recording Report:

Mr B Week 1

(27.08.08)

Mr B Week 1

Please copy this form and fill a new one in for each clinical session you record:

REPORT ON AUDIO RECORDING NUMBER ..... USING PROTOTYPE 1

1. File Name (as stored in laptop):...Mr. B. 27.08.08.....

2. Date of session: 27.08.08

3. Name of Therapist: Janet Graham

4. Name of Institution, Clinic or School: The Hawthorns

5. Patient Number or Pseudonym: Mr. B.

6. Patient Diagnosis: Severe brain injury caused by road traffic accident. Cognitive impairment, memory problems. Wheel-chair baound, but has good upper limb movements

7. Clinical Session Number: 19

Please List the Aims of this Music Therapy Session

1. Reduction of stuck rhythms
2. Growth of range of tempo
3. Increase of flexibility and expressive freedom

Please Write a Short Description of the Session

Mr. B. pushed himself in his wheel-chair to the session at the correct time. He started with the drum, and soon got into his customary jig rhythm. He also played the metallophone and blocks. He uses 1 beater in his right hand. Much of his playing was fast and limited rhythmically, though there was a little more creativity on the blocks. At one point he said that life is like music therapy in that we make it up as we go along. He was positive about the music.

Please list the instruments that had microphones attached in this session:

Drum
Electric piano
Metallophone
Blocks

Mr B Week 1

2

Overall was this a successful way of recording the session?

YES [Y]

NO [ ]

Any other comments arising from using prototype 1 for recording this session ?

Possibly part of the recording did not come out, as I lowered the laptop lid at one point and noticed a message on the screen later saying that something couldn't be done!

Date of Writing this Report ....27.08.08.....

Clinical Music Therapy Field Test Recording Report:

Mr B Week 2

(03.09.08)

Mr B Week 2

Please copy this form and fill a new one in for each clinical session you record:

REPORT ON AUDIO RECORDING NUMBER ..... USING PROTOTYPE 1

1. File Name (as stored in laptop):...Mr. B.03.09.08.....

2. Date of session: 03.09.08

3. Name of Therapist: Janet Graham

4. Name of Institution, Clinic or School: The Hawthorns

5. Patient Number or Pseudonym: Mr. B.

6. Patient Diagnosis: Severe brain injury caused by road traffic accident. Cognitive impairment, memory problems. Wheel-chair bound, but has good upper limb movements

7. Clinical Session Number: 20

Please List the Aims of this Music Therapy Session

1. Trying to get him out of his persistent jig rhythm
2. Growth of range of tempo (especially trying to slow him down)
3. Increase of flexibility and expressive freedom

Please Write a Short Description of the Session

Mr. B. was on time for his session. I did not have to go to fetch him from his room, as he was already on his way. He chose to start with the drum and soon established his usual jig rhythm. It had some rhythmic variation within it, but seemed stuck. I tried various ways of encouraging more flexibility and he sometimes shifted for a short time, but tended to revert to his jig. We talked about this afterwards. His metallophone-playing was rhythmically limited too, though his quick sideways tapping on the blocks produced a different sound. At the treble end of the piano (he chose the treble end) he used mostly the middle 3 fingers of his right hand in a narrow range, moving them quickly. He was positive about the session and said he had enjoyed it.

Please list the instruments that had microphones attached in this session:

Drum
Electric piano
Metallophone
Blocks

Mr B Week 2

2

Overall was this a successful way of recording the session?

YES [Y]

NO [ ]

Any other comments arising from using prototype 1 for recording this session ?

Not sure if the recording has come out, as haven't had time to listen.

Date of Writing this Report 03.09.08

Clinical Music Therapy Field Test Recording Report:

Mr B Week 3

(10.09.08)

Mr B Week 3

Please copy this form and fill a new one in for each clinical session you record:

REPORT ON AUDIO RECORDING NUMBER ..... USING PROTOTYPE 1

1. File Name (as stored in laptop):...Mr. B.10.09.08.....

2. Date of session: 10.09.08

3. Name of Therapist: Janet Graham

4. Name of Institution, Clinic or School: The Hawthorns

5. Patient Number or Pseudonym: Mr. B.

6. Patient Diagnosis: Severe brain injury caused by road traffic accident. Cognitive impairment, memory problems. Wheel-chair bound, but has good upper limb movements

7. Clinical Session Number: 21

Please List the Aims of this Music Therapy Session

1. Motivation
2. Increase of rhythmic flexibility and expressive freedom

Please Write a Short Description of the Session

Mr. B. was confused, as his session had been changed to the afternoon because he was too tired this morning. He had forgotten that he also had a physiotherapy session this afternoon and seemed generally confused, a little tired and rather cross. He was very willing to come for his session, but seemed less motivated than usual. He didn't want to play the metallophone or piano today. His rhythms on drum and cymbal were not in his usual jig rhythm, but were nevertheless repetitive. He played the blocks, often with little quick taps. After playing he said he had enjoyed it, but seemed less positive than usual about the music and especially his part in it.

Please list the instruments that had microphones attached in this session:

Drum
Electric piano
Blocks

Mr B Week 3 2

Overall was this a successful way of recording the session?

YES [Y]

NO [ ]

Any other comments arising from using prototype 1 for recording this session?

Not sure if the recording has come out, as haven't had time to listen.

Date of Writing this Report 10.09.08

APPENDIX 6:

Computational Music Therapy Analysis Test Reports

Dr Mathew Davies,
Centre for Digital Music
Queen Mary University of London
2008

Mr.B. Week 1 (27–08–08)

Mr B Week 1

Channel Information:

Channel Number	Instrument	Filename
1	Electric Piano	Mr.B.27.08.08-MIDI.mid.11.wav
2	Metallophone	Mr.B.27.08.08_2-Audio.11.wav
3	Blocks	Mr.B.27.08.08_1-Audio.11.wav
4	Drum	Mr.B.27.08.08_4-Audio.11.wav

Table 1: Summary of instruments used in each multi-track channel.

Aims of Session:

1. Reduction of stuck rhythms
2. Growth of range of tempo
3. Increase of flexibility and expressive freedom

Computational Analysis:

The music-silence segmentation is shown in Figure 6 with summary information about the musi shown in Table 2.

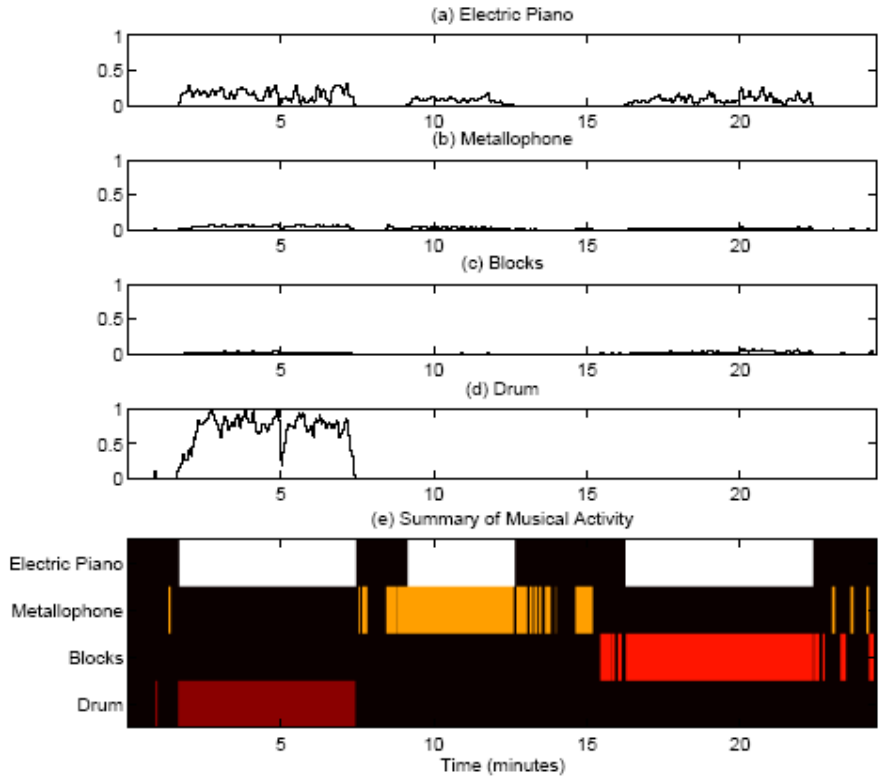


Figure 6: Music-silence segmentation. (a)-(d) Musical activity functions for each channel of the recording. (e) The summary visualisation of musical activity across all channels.

Mr B Week 1

Instrument	Percentage Activity	Duration (minutes)
Electric Piano	63.0%	15.4
Metallophone	25.2%	6.2
Blocks	29.9%	7.3
Drum	24.0%	5.9
Total Therapist	63.0%	15.4
Total Patient	79.1%	19.4

Table 2: Summary of musical activity in each channel.

The tempo contours for the therapist and patient are shown in Figure 7.

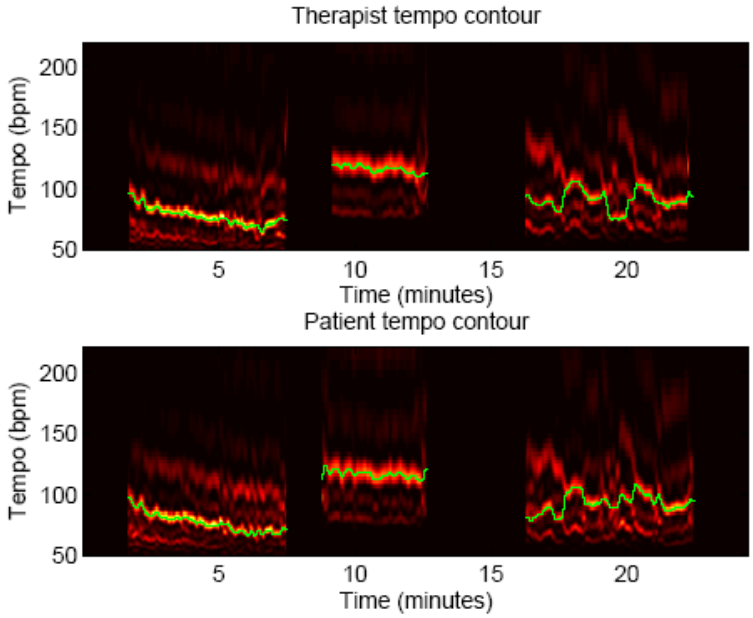


Figure 7: Tempo Contours across regions of musical activity. The orange ridges show the strongest tempi at each time, with the green line over the top showing the tempo contour for (top plot) the therapist and (lower plot) the patient. The regions of musical activity for the patient have been combined across all instruments used.

The extracted summary rhythmic patterns for each of the patient's instruments are shown in Figures 8–10 with summary information in Table 3.

Ability of Analysis to identify aims

1. Reduction of stuck rhythms
    - The stuck rhythm is characterised by a "jig" type pattern which is very prominent in the first improvisation (drum), less so in the second (metallophone) and not present at all in the third (blocks). This information is summarised in Table 3.
2. Growth of range of tempo
    - As can be seen from Figure 7, each improvisation is performed at a different tempo, with a gradual reduction in tempo in the first improvisation, a fixed faster tempo for the second and significant variation within the third.

Mr B Week 1

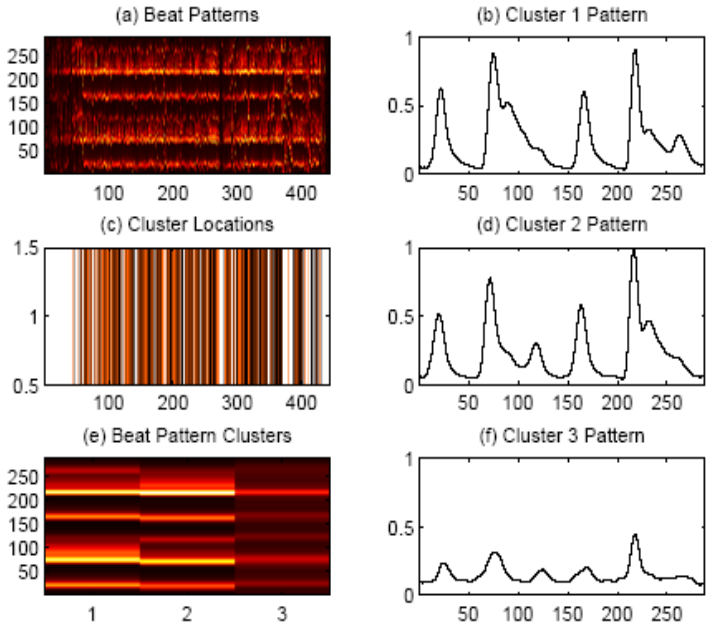


Figure 8: Drum: 1.6 – 7.4 minutes. Characterisation of repeated rhythmic patterns. (a) Two-beat analysis frames. (c) The cluster to which each beat belongs – the black lines refer to cluster 1, the orange to cluster 2 and the white to cluster 3. (e) The extracted beat clusters. (b),(d),(f) The two-beat patterns for clusters 1,2 and 3 respectively.

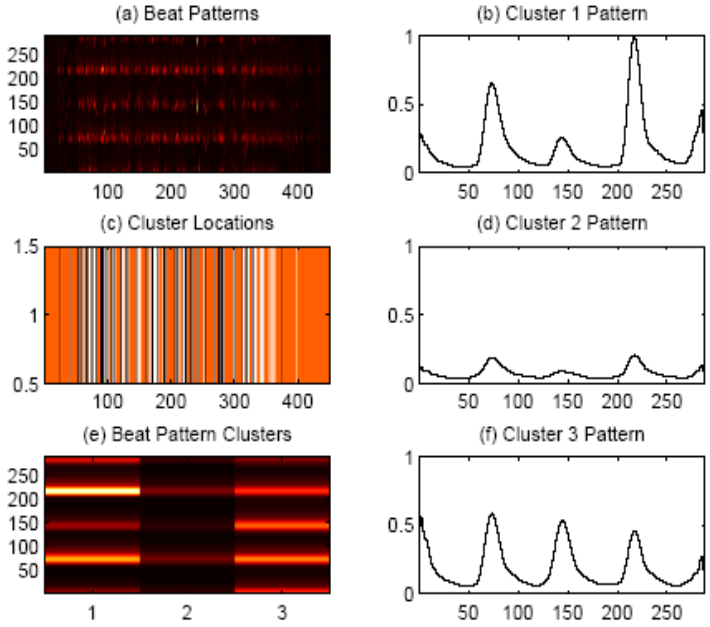


Figure 9: Metallophone: 8.8 – 12.6 minutes. Characterisation of repeated rhythmic patterns. (a) Two-beat analysis frames. (c) The cluster to which each beat belongs – the black lines refer to cluster 1, the orange to cluster 2 and the white to cluster 3. (e) The extracted beat clusters. (b),(d),(f) The two beat patterns for clusters 1,2 and 3 respectively.

Mr B Week 1

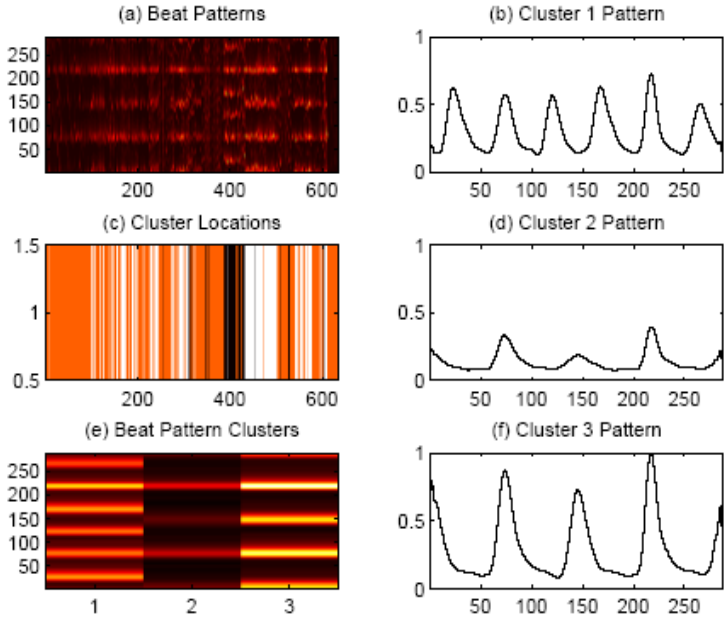


Figure 10: Blocks: 16.3 – 22.3 minutes. Characterisation of repeated rhythmic patterns. (a) Two-beat analysis frames. (c) The cluster to which each beat belongs – the black lines refer to cluster 1, the orange to cluster 2 and the white to cluster 3. (e) The extracted beat clusters. (b),(d),(f) The two beat patterns for clusters 1,2 and 3 respectively.

Instrument	Cluster 1	Cluster 2	Cluster 3	Stuck Rhythm Percentage
Drum	**35.0%**	**32.3%**	32.7%	67.3%
Metallophone	**16.4%**	62.2%	21.3%	16.4%
Blocks	8.8%	59.8%	31.4%	0.0%

Table 3: Summary of stuck rhythms. Stuck pattern clusters are shown in bold, which are identified with reference to the session notes made by the music therapist.

Mr B Week 1

3. Increase of flexibility and expressive freedom
    - This aim is more general and has not yet been tied directly to features extracted from the audio signals.

Was the analysis successful?: Yes

Problems in Computer Analysis:

The drum channel was particularly loud, which lead to significant over-spill into the other recorded channels. This increased the difficulty in isolating the musical activity for the metallophone and blocks channels.

Mr B Week 2

Mr.B. Week 2 (03–09–08)

Channel Information:

Channel Number	Instrument	Filename
1	Electric Piano	Mr.B.3.9.08-MIDI.mid.11.wav
2	Metallophone	Mr.B.3.9.08_4-Audio.11.wav
3	Blocks	Mr.B.3.9.08_2-Audio.11.wav
4	Drum	Mr.B.3.9.08_1-Audio.11.wav

Table 4: Summary of instruments used in each multi-track channel.

Aims of Session:

1. Trying to get him out of his persistent jig rhythm
2. Growth of range of tempo (especially trying to slow him down)
3. Increase of flexibility and expressive freedom

Computational Analysis:

The music-silence segmentation is shown in Figure 11 with summary information about the musical activity shown in Table 5.

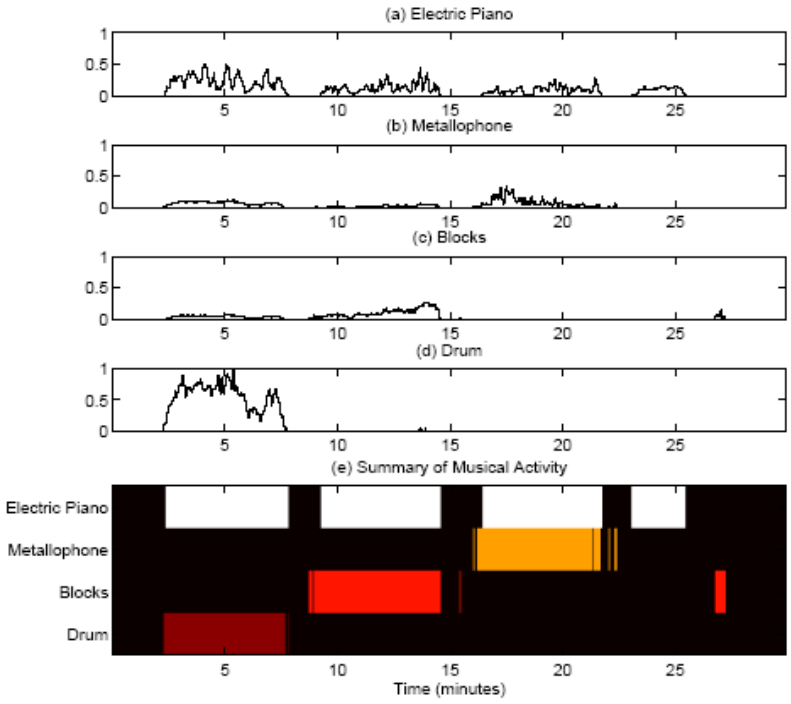


Figure 11: Music-silence segmentation. (a)-(d) Musical activity functions for each channel of the multi-track recording. (e) The summary visualisation of musical activity across all channels.

Mr B Week 2

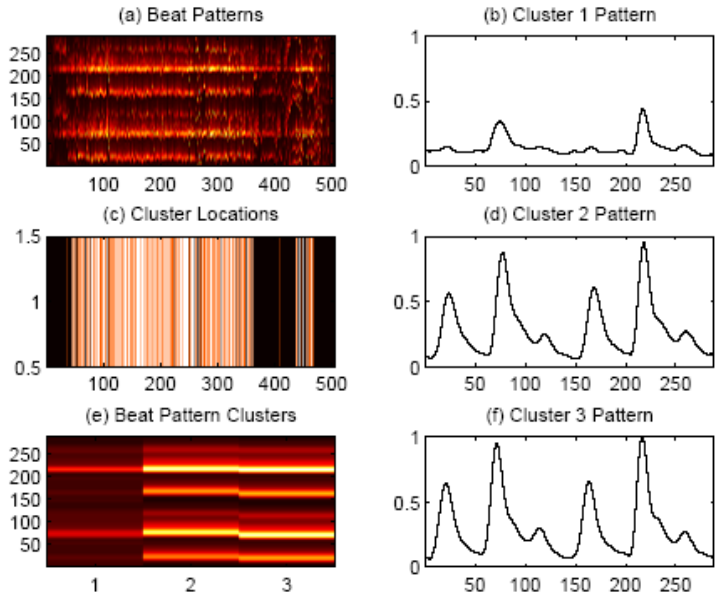


Figure 13: Drum: 2.3 – 7.7 minutes. Characterisation of repeated rhythmic patterns. (a) Two-beat analysis frames. (c) The cluster to which each beat belongs – the black lines refer to cluster 1, the orange to cluster 2 and the white to cluster 3. (e) The extracted beat clusters. (b),(d),(f) The two-beat patterns for clusters 1,2 and 3 respectively.

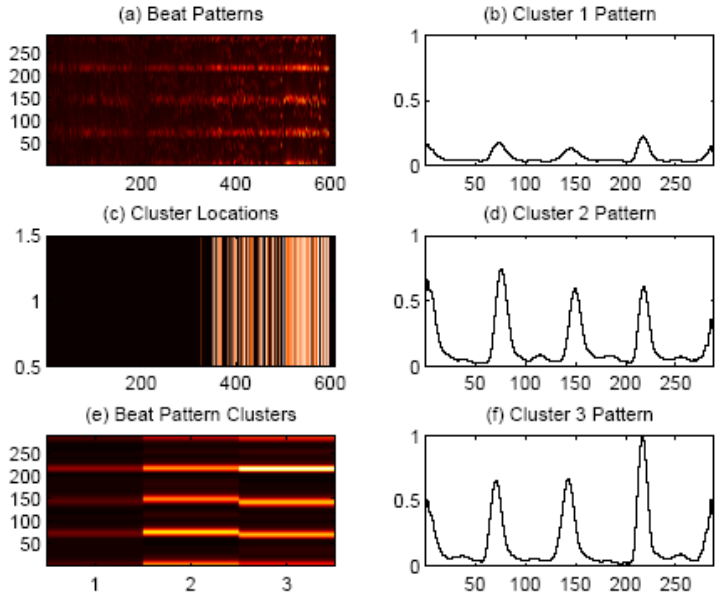


Figure 14: Blocks: 8.9 – 14.6 minutes. Characterisation of repeated rhythmic patterns. (a) Two-beat analysis frames. (c) The cluster to which each beat belongs – the black lines refer to cluster 1, the orange to cluster 2 and the white to cluster 3. (e) The extracted beat clusters. (b),(d),(f) The two beat patterns for clusters 1,2 and 3 respectively.

Mr B Week 2

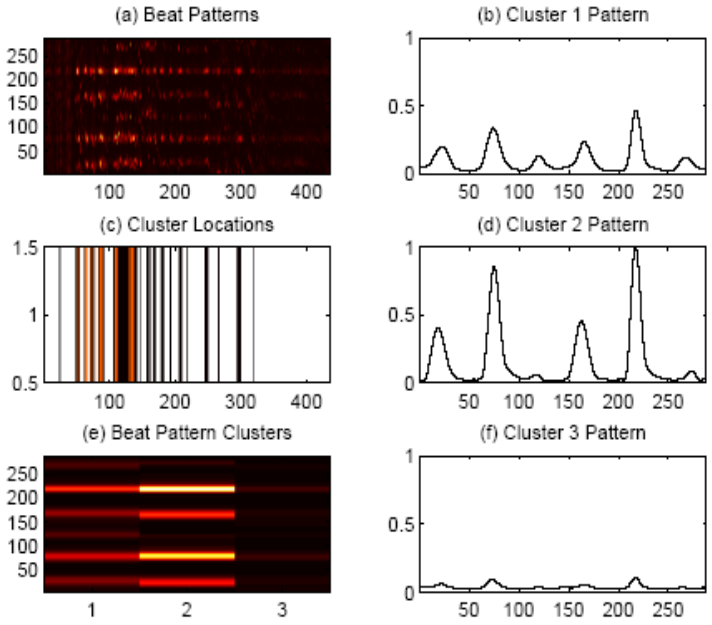


Figure 15: Metallophone: 16.2 – 21.3 minutes. Characterisation of repeated rhythmic patterns. (a) Two-beat analysis frames. (c) The cluster to which each beat belongs – the black lines refer to cluster 1, the orange to cluster 2 and the white to cluster 3. (e) The extracted beat clusters. (b),(d),(f) The two beat patterns for clusters 1,2 and 3 respectively.

Instrument	Cluster 1	Cluster 2	Cluster 3	Stuck Rhythm Percentage
Drum	36.8%	**28.1%**	**35.1%**	63.2%
Blocks	73.4%	14.9%	11.7%	0.0%
Metallophone	**19.8%**	**3.4%**	76.8%	23.2%

Table 6: Summary of stuck rhythms. Stuck pattern clusters are shown in bold, which are identified with reference to the session notes made by the music therapist.

Mr B Week 2

Instrument	Percentage Activity	Duration (minutes)
Electric Piano	61.9%	18.5
Metallophone	19.0%	5.7
Blocks	21.2%	6.3
Drum	18.2%	5.4
Total Therapist	58.4%	18.5
Total Patient	61.9%	17.5

Table 5: Summary of musical activity in each channel.

The tempo contours for the therapist and patient are shown in Figure 12.

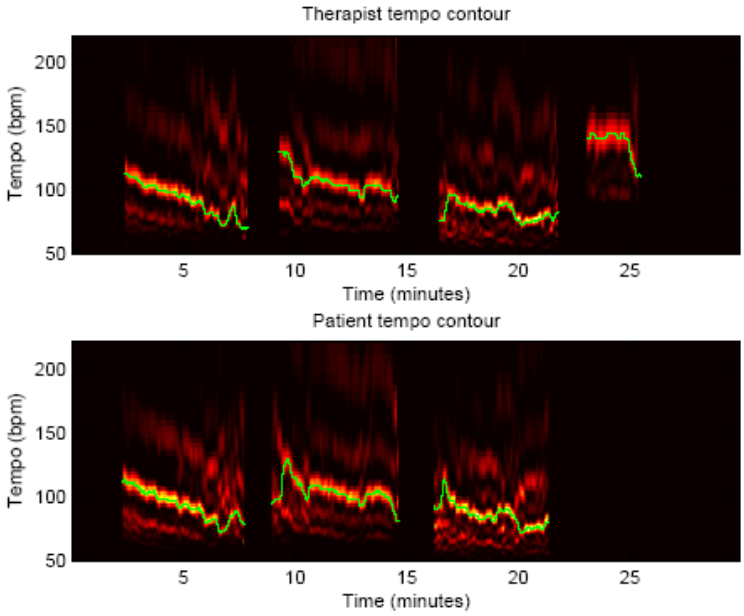


Figure 12: Tempo Contours across regions of musical activity. The orange ridges show the strongest tempi at each time, with the green line over the top showing the tempo contour for (top plot) the therapist and (lower plot) the patient. The regions of musical activity for the patient have been combined across all instruments used.

The extracted summary rhythmic patterns for each of the patient's instruments are shown in Figures 13–14 with summary information in Table 6.

Ability of Analysis to identify aims

1. Trying to get him out of his persistent jig rhythm
    - The jig pattern is most prominent in the drum improvisation, not present at all in the blocks and used for about one quarter of the metallophone improvisation. This information is summarised in Table 6.
2. Growth of range of tempo (especially trying to slow him down)
    - As can be seen from Figure 12, there is a clear pattern of reduction in tempo across each of the three improvisations.
3. Increase of flexibility and expressive freedom

Mr B Week 2

- This aim is more general and has not yet been tied directly to features extracted from the audio signals.

Was the analysis successful?: Yes

Problems in Computer Analysis:

There appears to be an additional region of musical activity in the blocks channel (approximately 27 minutes in). However this is not the result of musical playing, rather it caused by a burst of noise due to a minor failure of the signal acquisition system.

Mr B Week 3

Mr.B. Week 3 (10–09–08)

Channel Information:

Channel Number	Instrument	Filename
1	Electric Piano	Mr.B.3.9.08-MIDI.mid.11.wav
2	Drum	Mr.B.3.9.08_1-Audio.11.wav
3	Blocks	Mr.B.3.9.08_2-Audio.11.wav
4	Not used	Mr.B.3.9.08_3-Audio.11.wav

Table 7: Summary of instruments used in each multi-track channel.

Aims of Session:

1. Motivation
2. Increase of flexibility and expressive freedom

Computational Analysis:

The music-silence segmentation is shown in Figure 16 with summary information about the musical activity shown in Table 8.

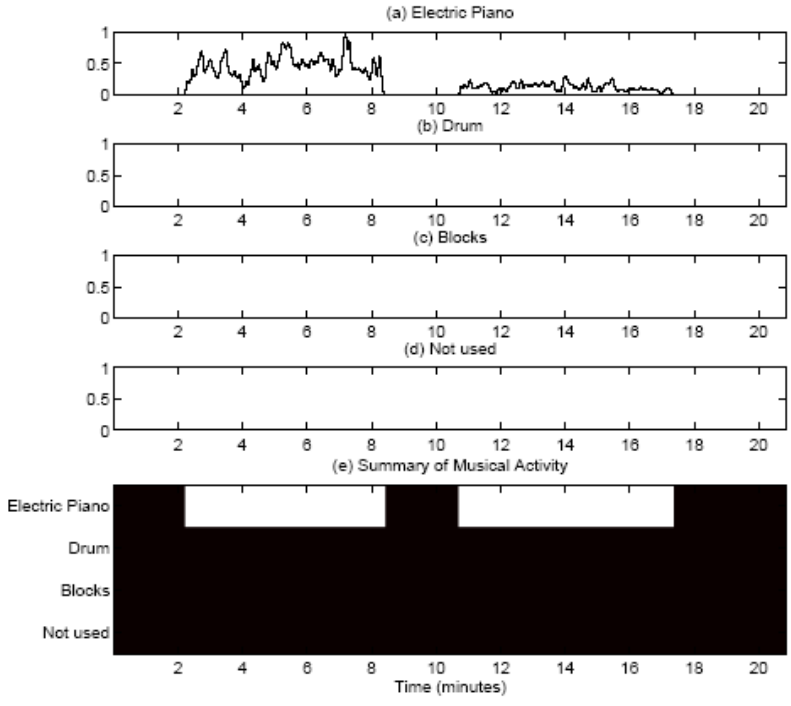


Figure 16: Music-silence segmentation. (a)-(d) Musical activity functions for each channel of the multi-track recording. (e) The summary visualisation of musical activity across all channels.

The tempo contours for the therapist and patient are shown in Figure 17.

Mr B Week 3

Instrument	Percentage Activity	Duration (minutes)
Electric Piano	61.8%	12.9
Drum	0.0%	0.0
Blocks	0.0%	0.0
Not Used	0.0%	0.0
Total Therapist	61.8%	12.9
Total Patient	0.0%	0.0

Table 8: Summary of musical activity in each channel.

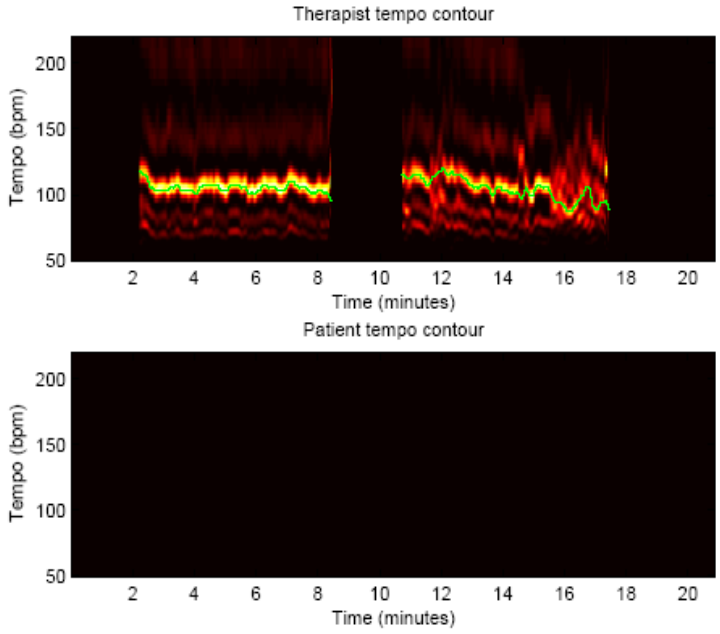


Figure 17: Tempo Contours across regions of musical activity. The orange ridges show the strongest tempi at each time, with the green line over the top showing the tempo contour for (top plot) the therapist and (lower plot) the patient. Due to the lack of audio data, no patient tempo contour could be calculated.

Ability of Analysis to identify aims

No audio signals were acquired from the wireless microphones. Only the MIDI track was successfully recorded.
Was the analysis successful?: No

Problems in Computer Analysis:

The signal acquisition failed.

INDEX OF FIGURES

(Figures Continued…)

(Figures Continued…)

(Figures continued…)

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