BRINGING MUSIC TECHNOLOGY TO MUSIC THERAPY: USING MAX/MSP AS A THERAPEUTIC AGENT

FINAL MASTER'S PROJECT
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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
MASTER OF MUSIC IN MUSIC TECHNOLOGY
IN THE DEPARTMENT OF MUSIC AND PERFORMING ARTS PROFESSIONS
IN THE STEINHARDT SCHOOL OF EDUCATION
NEW YORK UNIVERSITY

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DECEMBER 2003

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Introduction

Objective

This project is a learning opportunity that endeavors to bring together two separate fields of the music world – music technology and music therapy. The primary goal is to show music therapists and music technologists examples of how Max/MSP (Cycling74's Object-oriented MIDI and audio programming software) can be used as a practical music therapy tool. Max/MSP offers tremendous programming flexibility for both MIDI instruments and digital audio synthesis. However, the practicality of its employment in therapy remains to be seen. It is hoped that through these examples, music technologists and music therapists will be encouraged to work more closely to meet the needs of therapy clients and advance their respective fields. This project's implementation consists of:

- Examining the relationship humans have with music
- Research into music therapy
- Studying current employment of technology in music therapy
- Adaptation and modification of pre-existing Max patches for music therapy
- Original Max/MSP patches written for therapeutic use
- Feedback from a music therapist on the practicality for application of Max/MSP in therapy sessions.

This thesis paper aims to educate therapists about the potential of using modern music technology as a therapeutic agent, and at the same time inform music technology scholars about the remarkable work done in music therapy. It is written to inform and inspire both audiences. The accompanying CD-Rom contains this manuscript and the Max/MSP patches covered in the following chapters.

The task at hand poses a formidable challenge for the author, as I am neither an expert in programming Max/MSP, nor do I have a background in music therapy. Having become exposed to the extraordinary work of music therapists by taking Psychology of Music as an elective course in New York University's Music Technology Master's Degree program, it became clear to me that there should be a greater effort from individuals pushing the capabilities of music technology to become more involved in the effort to better the lives of clients receiving music therapy treatment.

The great strides being made in music technology should be utilized for more than entertainment and the pursuit of new kinds of musical expression. While these undertakings are noble enough in and of themselves, there is no reason why advances in music technology should stay primarily within the realm of such purposes. Why not apply these advances toward music therapy in the same manner that the creation of precision tools is applied to medical science? Video technology was not envisioned for surgery, yet it is being used every day in hospitals worldwide

to make surgery safer and less invasive. The list of medically adapted technologies from other fields is long, and music technology should be a fixture on such a list. The need for new tools has been created by medical science growth, and since the field of music therapy has evolved, music technology should be actively meeting these needs.

Therefore, even though I am neither an expert Max/MSP programmer nor Music Therapist, as a musician/ technophile/ humanitarian, through this project I aim to bring a greater awareness to the music technology and music therapy communities of the need for both groups to work more closely for mutual benefit and progress.

During a brainstorming session on 9/29/03, I sat with Dr. David Ramsey, Director of Music Therapy at the Institute for Music and Neurological Function at the Beth Abraham Family of Health Services. We discussed the power, function, and goals of music therapy and uses of technology to facilitate therapy goals in neurologically challenged patients.

Out of this discussion I was inspired to assemble a portable music composition system to be used in music therapy. Consisting of an Apple iBook laptop computer, a simple USB MIDI interface – M-Audio's Oxygen8, and Max/MSP patches, I will investigate the strengths and weaknesses of this system as a music therapy tool with Dr. Ramsey as an authority.

Figure I-1

Apple iBook (366 MHz CPU, 192 Megabytes RAM, OS X) running Cycling74's Max/MSP and M-Audio Oxygen8 MIDI controller.

Assumptions

Regardless of my experience level in programming Max/MSP, knowing it's versatility and potential makes it clear that Max/MSP is an excellent tool for more than composition and interactive performance. The very reason Max was initially written (the MSP extension was added years later when Max reached beyond MIDI to digital audio synthesis) was to give its users the ability to have truly versatile control of electronic hardware. Max/MSP has always been used in creative applications, fueled by the imagination of composers, performers, and programmers. Why not take this further by acknowledging music therapy clients as composers and performers? The

very practice of music therapy empowers them as such. Once this is recognized by the world outside of music therapy, their need for innovative music creation tools can be more adequately addressed.

Chapter 1

Our Relationship With Music

"We are physical beings living in a physical world. From the moment of our birth we have been manipulating our environment in order to get comfort, to accomplish something. We reach, slap, grasp, and tap things in our environment and we feel our bodies move, we calculate each move throughout every millisecond of the movement and 'know' how well we are accomplishing our task through feedback related to the physical world. The things we tap produce sound, the things we grasp produce sensations in our hand, etc. We sub-consciously identify and define ourselves as physical manipulators. This identification with our physical self is referred to by some as the 'neuro-self.'" (Ramsey via email, 2003)

Communication and Self-Expression

We humans need to interact with our environment. If we are to fulfill even a modicum of our potential, we need to interact with our surroundings as surely as we need air, food, and water to survive. To achieve growth,

communication and self-expression are fundamentally essential. While these traits are often obviously displayed, there are many different ways we interact with our surroundings that are taken for granted and not in plain view.

Our senses – sight, hearing, touch, taste, and smell, are as covert as they are powerful. We expect them to be at our instantaneous command. Even when they are appreciated, these senses still function as a matter of course in our normal existence. As a species, we define ourselves and our world through physical and emotional communication made possible by these natural gifts.

Think for a moment about how difficult it would be to have any one or more of these senses hampered or taken away midway through one's life. Is it the same as having a disability at birth? It can be argued that people born with disabilities have less difficulty facing their challenges as opposed to people who face disabilities brought on by accidents or sickness later in life. While the brain and body have to compensate for a disability from birth, this is less daunting a task than compensating *and* learning to live without an ability one has had and relied on his whole life.

Regardless of how or when a person is challenged with a disability, music therapy has the potential to rehabilitate and promote dignity in clients to varying degrees, primarily because it restores/creates new ways of

dynamically communicating and interacting with other human beings and our environment.

Music's Innate Connection to Our Individuality

While oral communication and gestures may be the most obvious communication tools, there are many indirect ways by which we define our environment and ourselves. Considering our innate musicality, the definition of self-expression and communication can be broadened, for example, when we realize that rhythmic gestures can help a child realize a sense of his or her own space.

It is not uncommon to see a child physically respond to rhythm and melody before he or she has gained experience walking. My cousin Nicole, now 9, used to enjoy dancing (in an unsophisticated, reactionary form) to a modern jazz/pop song, Sade's "Hang On To Your Love," before she was able to walk and run with a fluent command of her body. By way of this "dancing," she was able to become more accustomed to her physical self. Unquestionably, this experience improved her coordination skills.

Though not as overt as running, dancing (which mainly consisted of swaying, sidestepping, and moving her arms) in a simple manner helped Nicole grow while she connected with this one particular song that she recognized and liked at only a few years old. Through this process, she further defined her physical identity.

In realizing her attraction to the melody and beat, Nicole reacted by experimenting with her body's range of motion. Simultaneously, she enhanced her awareness of the objects and people in the room, so as not to bump into anything. Through her self-expression by enjoying a piece of music, she gained a sharper command of herself and an enhanced understanding of her surroundings. To be sure, knowing the adults in her family were very entertained by her performance undoubtedly fostered positive psychological feedback as well. Her natural development mirrors the process and goals of clinical music therapy, as will be discussed in Chapter 2.

A Musical Species

We are a musical species. "Music is a universal experience in the sense that all can share in it; its fundamental elements of melody, harmony, and rhythm appeal to, and engage their related psychic functions in each one of us. Music is also universal in that its message, the content of its expression, can encompass all the heights and depths of human experience,

all shades of feeling. It can lead or accompany the psyche through all conditions of inner experience, whether these be superficial and relatively commonplace or profound and deeply personal." (Nordoff and Robbins, 1971, 1985)

Music plays a vital role in our survival and evolution. Without realizing it, music helps us understand our bodies and environment. As toddlers and as we grow, music helps us express ourselves physically and emotionally. It is a communication bridge that is simultaneously mysterious and corporeal. Rhythms and melodies have great power by which we can be affected and through which we can communicate with our world and those around us.

In *Music As A Psychotherapeutic Agent,* Leonard Gilman and Frances Paperte write: "Through the ages the influence of music over mind, body, and emotions has manifested itself so diversely and so frequently that its existence is no longer denied. In response to harmonious sounds, recorded changes of moods, influence on appetite, sleep, and general well being have occurred too often to be ignored or taken for granted. … Confucius not only loved music but ascribed to it social virtues. He believed that ritual and music were the clues to harmonious living. In the Fourth Book of *The Republic,* Plato states that health in body is to be obtained through music and gymnastics and should continue throughout life. Aristotle ascribed the beneficial and medicinal effects of music to an 'emotional catharsis,' a view subscribed to by many psychiatrists today." (Gilman and Paperte, 1949)

Music's Communicative Power

"Music is a universal means of communication. It has been called a non-verbal language. What has yet to be recognized is the range of expression that is possible in this 'language.' The variety of human expression that can be communicated through music is highly diversified and virtually unlimited. Because of this, music becomes vitally important as therapy for exceptional children." (Nordoff and Robbins, 1971, 1985)

While music therapy is often used to help autistic children and others who suffer from disabilities at birth, there is at the same time a large number of therapy clients who have come upon disabilities later in life through accidents or sickness. As mentioned earlier in this chapter, these clients arguably have even more obstacles to overcome. Not only do they have to deal with these disabilities brought on during adolescence or adulthood, but also have to re-learn how to live, communicate, and reaffirm their dignity.

The challenge for the music therapist is to harness the somewhat illusive power of music and creatively pursue various avenues of therapy tailored to the specific needs and goals of each individual client.

The range of client disabilities is vast. In many cases, clients are physically, mentally, *and* emotionally impoverished. This does not suggest that a client with any one or all three of these types of disabilities is less

inclined to benefit from music therapy. Rather, people who are classified as such are potentially able to experience "living" through music as anyone else. In fact, music may be the only way these individuals can escape or overcome their disabilities. "When patients get lost in jamming during a musical improvisation, they are at the same time using muscles, firing off neglected neuro-networks and increasing physical range of motion. This is important from a rehabilitation standpoint, but also at the same time that they are exercising, they are conversing with others, creating an esthetic work, and expressing themselves emotionally." (Ramsey via email, 2003)

Arguing for Greater Use of Music Technology in Music Therapy

In answering the challenge to harness the communicative power of music for therapeutic healing, the field of music therapy must accept the responsibility to grow with music technology breakthroughs and seek to employ them as a means by which the power of music can be more efficiently tapped into by a greater number of clients. This can only benefit all involved. Likewise, the field of music technology must expand beyond its commercial and artistic boundaries to become more than it is. "…There has not been a comprehensive effort to discern the adequacy or appropriateness of the inclusion of digital music technology in the music therapy process. This is troubling when you consider that in the last decade, these instruments

have inspired a revolution in the manner in which music is created. This revolution appears not to have included many therapists. Therapists, many of whom appear to be intrigued by digital instruments, have not reported explorations of their use in a clinical setting." (Nagler 1993)

If music therapy is to continue its evolution as a bona fide form of treatment and gain wider acceptance in the medical field, than it must embrace the technological achievements made in recent years. A symbiotic relationship between technology and therapy communities is necessary. It will, by definition, serve to push both fields to achieve their current goals as well as inspire new ones.

Figure 1-1

Collective Benefit of Music Technology and Music Therapy working Together for Clients

Chapter 2

Music Therapy

What is Music Therapy?

"Music therapy provides a framework in which a mutual relationship is set up between client and therapist. The growing relationship enables changes to occur, both in the condition of the client and in the form that the therapy takes…. By using music creatively in a clinical setting, the therapist seeks to establish an interaction, a shared musical experience leading to the pursuit of therapeutic goals. These goals are determined by the therapist's understanding of the client's pathology and personal needs. (Association of Practicing Music Therapists, 2000a)

'Music therapy is the use of sounds and music within an evolving relationship between client/patient and therapist to support and

develop physical, mental, social, emotional, and spiritual well-being.' (Adapted from Bunt 1994: 8)" (Bunt and Hoskyns, 2002)

Essentially, music therapy aims to use the communicative power of music to help patients with a variety of physical and mental challenges. By means of the interaction with rhythms and melodies, music therapy patients can:

1. Increase physical strength
2. Increase range of motion throughout the body as well as specific joints and muscles.
3. Experience positive psychological growth by nurturing self-confidence.
4. Be liberated (to varying degrees) from their disabilities.

The Music Child

"Handicapped, normal and retarded people of all ages show four major reactions to music: 1) physical; 2) sensuous; 3) intellectual; and 4) emotional (Alvin, 1973.) The two overriding needs of all impaired clients and of all children are the needs for security and for independence. Music can provide for these needs, and does by its very nature. Rhythm in music gives order and structure; repetition of

melody, underlying forms (such as Rondo) and modulations away from and back to basic tonalities inherently provide orderliness and security. The independence and satisfaction from the four reactions to music are tied to the concept of the `Music Child' (child here not necessarily connotating a young person.)

As developed by Paul Nordoff and Clive Robbins, the concept of Music Child proposes that within every handicapped individual lives a real being, an individuality, that is not handicapped in any way, which functions regardless of impairment. It is something that works within on the personality of the individual and finds expression through music. The Music Child (or creative soul) begins and is nourished by the music the therapist makes with the client either vocally or through instruments." (Clark and Chadwick, 1979/1980)

The importance of recognizing the Music Child concept as the gateway to understanding the needs and potential of clients is paramount for successful therapeutic results. Additionally, if those outside of music therapy accept the idea of the Music Child, clients will eventually benefit. The Music Child concept applies to everyone, and therefore provides a common ground for clients, therapists, and average healthy individuals in all walks of life. Therefore, once this connection is established to those outside of music therapy, (electronic music composers, software programmers, instrument designers, etc.) perhaps greater support will be given to provide music

therapists with modern, innovative tools customized toward individual client needs.

The Music Therapy Spectrum

The music therapy spectrum focuses on six approaches that can underpin music therapy practice. (Bunt and Hoskyns, 2002) This model illustrates these approaches, with music as the common link by which all methods seek to achieve their goals.

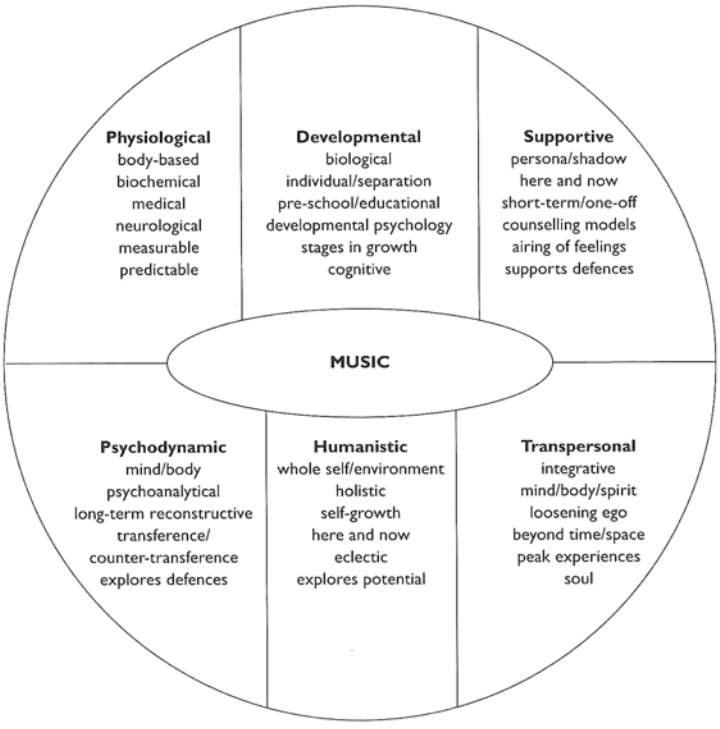


Figure 2-1

The Music Therapy Spectrum (Bunt and Hoskyns, 2002)

Nordoff-Robbins Music Therapy

The work of Paul Nordoff and Clive Robbins pioneered music therapy as a treatment for autistic children. From their early works in the 1950s to the present, the Nordoff-Robbins approach has not only proven successful, but still serves as the blueprint for music therapy.

> "The Nordoff-Robbins approach to creative music therapy is based upon the belief that there is an inborn musicality residing in every human being that can be activated in the service of personal growth and development. This self-actualizing potential is most effectively awakened through the use of improvisational music in which the individual's innate creativity is used to overcome emotional, physical, and cognitive difficulties. In this form of co-creative endeavor, clients take an active role in creating music together with their therapists on a variety of standard and specialized instruments. Because instruments can be chosen which are expressively gratifying yet do not require special skills to play, no prior experience or training in music is required of clients.
>
> Nordoff-Robbins therapists work worldwide with a broad range of people, including disabled children, individuals under psychiatric care, self-referred adults seeking a creative approach to emotional difficulties or personal development, and individuals with medical problems and in geriatric care. In all of its applications this work

emphasizes the potency of individualized musical experiences as a means of developing relationship and the inner resources of clients. Spontaneous, clinically directed musicianship is combined with a humanistic concern for the needs and growth potential of the individual in overcoming the barriers to a more gratifying life imposed by disability, disease and trauma. Music and musical experience are the primary areas in which the therapist intervenes and in which the client's development takes place." (Nordoff-Robbins Center at NYU website, http://www.nyu.edu/education/music/nrobbins/whatis.html 2003)

Figure 2-2

Image from Nordoff-Robbins Center at NYU Website.
(http://www.nyu.edu/education/music/nrobbins/index.html 2003)

Chapter 3

Technology in Music Therapy

Being a music technology aficionado, I assumed that music therapists would naturally be using electronic instruments, MIDI, and digital audio as standard therapeutic tools. While there are indeed therapists who use electronic instruments in their work, the field of music therapy has only begun to scratch the surface of what digital music technology can offer.

On the surface it would seem as though a relationship between technology and therapy is non-existent. Truth be told, technology *is* a part of music therapy. Therapists are constantly challenged to discover creative ways of meeting client needs. Often, they rely on ingenuity by adapting acoustic instruments and inventing unorthodox instruments to get clients actively involved in making music.

In terms of electronic applications, sessions are videotaped as a matter of course in modern music therapy. The advent of user-friendly

digital video tools makes this a very attractive method for logging client progress and further study of client diagnosis.

Figure 3-1

Image from Nordoff-Robbins Center at NYU Website.
(http://www.nyu.edu/education/music/nrobbins/index.html 2003)

However, the application of technology in music therapy has origins in more creative leanings in the adaptation of acoustic instruments for use by clients with a variety of handicaps. "The application of music and technology in the music therapy is not a new idea. The literature suggests that there are a myriad of applications of music and nondigital technology in the music therapy. Many patients have undergone successful treatment while attaining the ability with the aid of adaptive devices. These devices include modifications of instruments and objects used to play instruments." (Nagler, 1993) Since meaningful music therapy requires the involvement of clients to create and react to rhythm and melody, the therapist must find ways to enable clients to manipulate sound.

Adapting Acoustic Instruments for Music Therapy

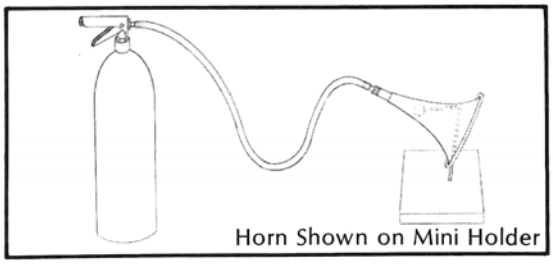
The following are images and illustrations of various instruments that have been adapted for clinical use.

Figure 3-2

Figure 3-3

Wheelchair Tray Instrument Holder
(http://www.adaysworkmusiceducation.com/wheelchairtraymount.html 2003)

The Wheelchair Tray Instrument Holder in **Figure 3-2** and **Figure 3-3** is commercially available from www.adaysworkmusiceducation.com. This stand has a variety of applications, as it enables wheelchair-bound clients the opportunity to play different percussion instruments.



Compressed Air Sounder

Description: A standard 5-10 gallon tank of compressed air comes equipped with a hose extender. A 2-inch flexible rubber tube can be fitted onto the end of the hose, which then fits over the reed end of a horn or other wind instrument. The instrument can then be placed into a horn or hand held frame (see Frames). For persons who are physiologically unable to blow a horn, this adaptation allows a positive interaction with the instrument. It helps those with limited respiration and oral control to produce wind sounds through a non-oral medium.

Usage: To sound the instrument, the client depresses or trips the lever which expels a burst of air. Even gross movements can be directed toward pushing the sounding lever, which is appropriate for upper and lower extremities.

Contraindications: This adaptation should not be used by persons who have the potential to develop horn playing skills. The Compressed Air Sounder is not a developmental device — it is only intended as a substitute for blowing ability.

Contributors: *Donna Chadwick and Cynthia Clark*

Figure 3-4

Images scanned from Clinically Adapted Instruments for the Multiply Handicapped (Clark and Chadwick, 1979/1980)

Figure 3-5

Handled Holder

Description: The Handled Holder, an adaptation that can be used with a variety of wind instruments, is made from a standard bicycle grip in which an expandable clamp has been embedded. The clasp grips the horn at midpoint; other instruments are inserted at their most effective point for easy manipulation. This adaptation is designed for clients who exhibit weakness of general or specific musculature as well as lack of refined grasp. Squeezing the bulb with one or both hands encourages palmar grasp. Elbow flexion causes the horn to be raised to the lips and arm and hand stabilization holds the horn in front of the face for repeated blowings. For a weaker client, the horn can be raised and lowered between blowings.

Usage: Once the horn, recorder, owl or other wind instrument is secured in the clamp, the client should bring the instrument up to his or her mouth by raising the hand that is holding the bicycle grip. The client accomplishes this with his or her hand in an ulnar side down position and brings the bicycle grip up to almost the chin level.

Contributors: *Gail Rebello and Joan Freedman*

Figure 3-4 and **Figure 3-5** illustrate ways in which wind instruments can be physically adapted for clinical use. Ultimately, the traditional adaptation of acoustic instruments for therapeutic use has been driven not only by client needs, but also by the ingenuity of music therapists. If modern electronic music technology is to be employed in therapy, however, hands-on involvement of designers and engineers of such music technology is necessary. Simply put, the technology grows and changes so rapidly, it is particularly challenging for someone not actively involved in music technology to comfortably keep up with it.

Potential Music Therapy Instruments

"I have chosen to use digital music technology in clinical music therapy work because of frustrations I encountered in musical interactions with patients. The improvised music created with traditional instruments in clinical practice often suffers from a lack of continuity." (Nagler 1993)

Considering all the innovative work that is being done regularly in electronic and interactive music, the opportunity here is clear: once musical input and composition is decided upon being done electronically, adapted acoustic instruments for music therapy are no longer the only option at therapists' disposal. Worldwide, music technology is constantly giving birth to new and innovative instrument interfaces, software, and methods of audio

synthesis. The technology is available, and should be exploited by music therapy.

Granted, sometimes the best place to start therapy with a client is to give him a stick and a drum (assuming the client has the proper physical ability, etc.) According to Dr. Ramsey, this type of physical control is crucial as it establishes a cause-and-effect relationship between client and environment. Currently, he employs the use of MIDI triggers that enable him to analyze the data of velocity and timing. "I prefer to use MIDI triggers that are obvious in that you hit them and one sound comes out, or you squeeze an instrument the squeezing changes the sound accordingly." (Ramsey via email, 2003) Since it is becoming more common for non-traditional electronic music instruments to be created and configured to interact with computers via MIDI, music therapists should reach out to various organizations and schools like IRCAM and MIT to facilitate the creation of non-traditional instruments for therapeutic application.

Some very intriguing work in composition with unorthodox music instruments is being spearheaded by Tod Machover of MIT. A respected composer and inventor of electronic music instruments, Machover's *Toy Symphony* is just one example of his innovative approach to music composition by way of original electronic instrument interfaces. *Toy Symphony* is a large work that involves children and interactive composition with custom-made unorthodox instruments "through the use of innovative

technologies to create musical instruments and compositional tools designed for an individual of any skill level…" (www.toysymphony.net 2003)

Figure 3-6 and **Figure 3-7** are examples of *Toy Symphony* instruments have great potential if used in music therapy. Being that the purpose of these instruments is to be simple enough for children to compose with, they are inherently excellent candidates for music therapy clients, since they must also be considered composers, too. The varying degrees of client limitations, although obviously quite different from those of normally developing children, makes their *abilities* similar to children's in the sense that they are simple. While children are expected to grow beyond this simplicity of function, disabled people and neurologically challenged persons are almost never expected to fully overcome their disabilities. However, through music therapy, these disabilities can be made more manageable since the interaction and creation of music enables clients to reach beyond their limitations.

Figure 3-6

Toy Symphony Beatbug

"Beatbugs are hand-held percussive instruments which allow the creation, manipulation and sharing of rhythmic motives through a simple interface. When multiple Beatbugs are connected in a network, players can share and develop rhythmic patterns to form larger scale compositions. The players themselves choose between manipulating existing motives and entering their own material, in essence creating a dynamic and collaborative music that is truly more than the sum of its parts."

(Image and text www.media.mit.edu/hyperins/ToySymphony/musictoysbb.html 2003)

Figure 3-7

Toy Symphony Music Shaper

"Music Shapers are soft, squeezable instruments, which allow players to mold, transform, and explore musical material and compositions. Using capacitive sensing and conductive embroidery to measure the squeezing gesture, Music Shapers allow children access to high-level musical parameters such as contour, timbre, density and structure, rarely accessible through traditional musical instruments or pedagogy except after many years of study and mastery. The effect is that of 'conducting' musical phrases and forms in a very tactile, visceral and enjoyable way."

(Image and text www.media.mit.edu/hyperins/ToySymphony/musictoysshape.html 2003)

Toy Symphony-like instruments are ideal for music therapy in that they don't require any specific musical ability to operate. These instruments bypass the need for traditional physical music-making skills, and they allow for interaction through networking and improvisation. Even though *Toy Symphony* instruments are aimed at children, they are pleasing and interesting for all ages. Thus, utilizing instruments like these would not

impinge upon the dignity of adult music therapy patients who are challenged with disabilities later in life due to illness or accident.

Chapter 4

Applying Max/MSP as a Tool in Music Therapy

"Traditional instruments have long been included in music therapy, but for many clients their use has been frustrating and impossible. This experience, in turn, damages self-concept and hinders further efforts. For individuals with involuntary neurological impulses, missing limbs, and restricted motor abilities, adaptive equipment or assistance is necessary." (Clark and Chadwick, 1979/1980) The preceding quote from Clinically Adapted Music Instruments for the Multiply Handicapped was written with the modification of acoustic instruments in mind. It's meaning, however, is perhaps even more pertinent today when we consider the virtually limitless possibilities available through electronic music technology. "There is a need for the identification and implementation of a new class and genre of instruments which can provide the necessary expressive and therapeutic opportunities for both patient and therapist. Digital music instruments provide the link for creating congruence between the music present in the cultural lifeworld of the child and the music presented in the music therapy

session." (Nagler, 1993) While Nagler's assessment pertains specifically to his work with children, this statement does not exclude adult patients from enjoying the advantages of digital music instruments, especially since these instruments have become even more commonplace in the decade since he completed his doctoral dissertation.

What is Max/MSP?

Max/MSP, Cycling 74's object-oriented programming language, offers musicians and programmers a plethora of tools through which MIDI and digital audio can be synthesized, controlled, and analyzed.

Max was written by Miller Puckett in the mid 1980s to control an experimental synthesizer called the 4X. "Max was published in late 1990 and quickly became an almost universal solution for problems that required customized software." (Chadabe, 1997)

In describing Max, Todd Winkler writes, "Max borrows some of the best aspects of other programming languages and combines them into a package geared specifically to real-time computer music applications: it has an intuitive graphical user interface, it comes with a collection of graphical objects for building custom interfaces, it can create stand-alone applications,

and it allows unlimited expandability by breaking out of the Max environment to include external objects written in C." (Winkler, 1998)

The MSP extension to the software enables Max programmers to delve into digital audio synthesis, essentially freeing users from relying solely on outboard MIDI tone generators for their "sounds." Now, Max/MSP users can literally invent their own digital instruments, create plug-ins and effects for popular software, and realize just about anything imaginable for MIDI and digital audio.

How does Max/MSP Work?

Max uses objects to represent and carry out mathematical functions. These objects have inlets and outlets, and can best be thought of as components in a rack of audio gear. Signal comes in, gets processed, and then comes out to be heard. These objects can be number boxes, knobs, sliders, meters, graphs, etc. Once a Max user's goal is identified, the programming unfolds into a signal flow from one object to the next, until the desired output is achieved.

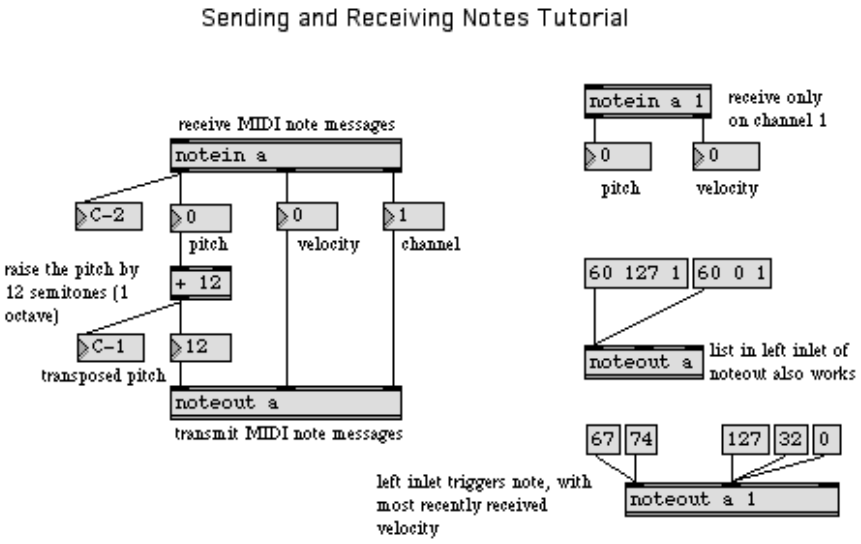


Figure 4-1

Sending and Receiving MIDI Notes, Tutorial 12 from **Max43TutorialsAndTopics.pdf** (Zicarelli, Taylor, Bernstein, Schabtach, and Dudas, 2000-2003)

The concept of how Max works is fairly easy to digest in these terms. Programming in Max, however, is entirely different. It's much like the relationship between the designer and builder – while it's one thing to create a design for a vehicle or a skyscraper, making it reality is another thing entirely. Programming in Max requires above-average computer skills, working knowledge of MIDI and audio systems, and musicianship.

Getting the Portable System Running

The portable system used for this project (**Figure I-1)** is a typical representation of power and portability for electronic music. Even though the

iBook is a few years old, the 366 MHz CPU and 192 megabytes of memory run Max/MSP smoothly. The M-Audio Oxygen8 controller is sturdy, lightweight, and simple to use. The entire system is easy to manage and sets up in minutes. If, for example, an unorthodox instrument interface like the *Toy Symphony* Beatbug or Sound Shaper was made to replace the Oxygen8 as the interface, it is clear that this type of system has great potential when combined with appropriate software.

The operating system on the iBook is Mac OS X 10.2.8 (Jaguar.) Being that Jaguar's MIDI and audio architecture are different than in Mac OS 9, an unforeseen issue arose and needed to be immediately addressed. In OS 9, Max utilizes the operating system's built-in QuickTime Music Synthesizer directly through third-party software called OMS (Open Music System.) This enables the Max user to hear a basic MIDI synthesizer palette without adding any extra outboard MIDI modules.

"The QuickTime music synthesizer component is a software-based synthesizer that is included with QuickTime. The sound it generates can be sent to the built-in speaker of a Macintosh or Mac OS-based computer or to the sound card or built-in audio circuitry of other computers."

(http://developer.apple.com/documentation/QuickTime/REF/tp_qtma_aboutqtma.8.htm)

Being that OS X's new design eliminates the need for OMS, (and the Oxygen8 keyboard is only a USB MIDI interface/controller with no onboard tones) it seemed at first the only way to hear any sounds would be to add

another outboard MIDI tone module. While this is certainly easy enough to accomplish via the Oxygen8's MIDI I/O, adding more equipment would undermine one of the system's greatest strengths – compact portability.

Fortunately, upon further reading of Cycling74's website, in the FAQ section there is a link to download a Max object that solves this problem. Written by David Zicarelli but not included with the distribution installation of Max/MSP 4.2.1, the **qtmusic** object allows for direct interface with the QuickTime Music Synthesizer under OS X.

Figure 4-2
Qtmusic object written by David Zicarelli
http://www.synthesisters.com/download/qtmusic.sit

Using this object in place of a **noteout** object allows for this portable system to be truly self-contained. While it is certainly possible to add extra MIDI gear or add MSP audio synthesis for additional sounds, for purposes of this project, the **qtmusic** object is the ideal solution.

Conductor Model and Adapted Conductor Model Patches

Todd Winkler's book, Composing Interactive Music: Techniques and Ideas Using Max, contains a wealth of efficiently designed Max patches intended for interactive composition. What Winkler has done in his book is take the blank slate of a new Max patch – which can be quite intimidating for a novice programmer – and turn it into a host of very practical composition tools. Although not being designed with therapeutic purposes in mind, these patches show a great deal of potential for therapy if adapted accordingly.

The patch worked with on this project is the **Conductor Model**. This patch contains a Chopin prelude stored in a **coll** object and is engaged by the user who controls playback of the piece through tempo input. On its own, this patch has all the earmarks of a very useful therapeutic tool. Clients who are neurologically and physically challenged (and for whom playing a piano or violin would be impossible) are empowered with the ability to play this Chopin piece merely by tapping the sustain pedal attached to a standard MIDI keyboard. Further, any piece of music could be stored in the **coll** object by numerically representing note pitches, thereby enabling variety. (Note: the Chopin prelude is ideal since its rhythmic pattern is constant. Pieces with such rhythmic patterns are best for this patch, as they inherently require simple, controlled input to achieve the desired results.)

What makes this particular patch very useful in terms of music therapy is that it utilizes very simple physical input to determine tempo, and creates large, detailed musical output from the tempo. For many clients, this ability would be a great gift.

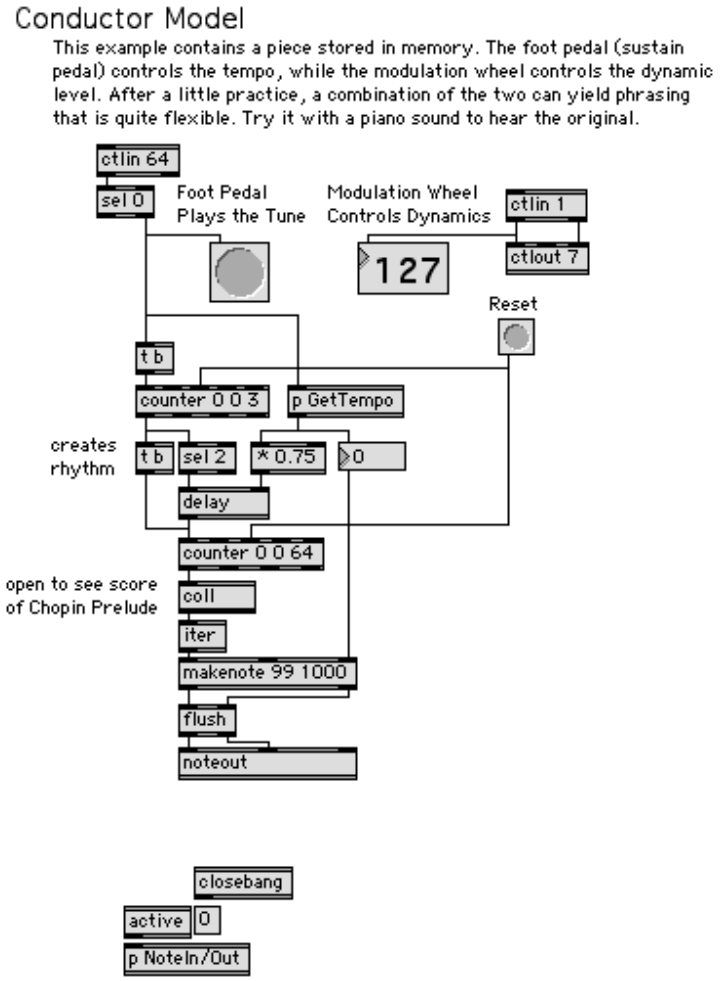


Figure 4-3
Conductor Model Patch, Todd Winkler (1998)

To enhance the functionality of this patch for therapy purposes, I have adapted it to include the use of the Oxygen8 keyboard in addition to the sustain pedal. If the **Adapted Conductor Model** patch was to be used

in a therapy session, the therapist now has options as to how to have the client interact with the hardware.

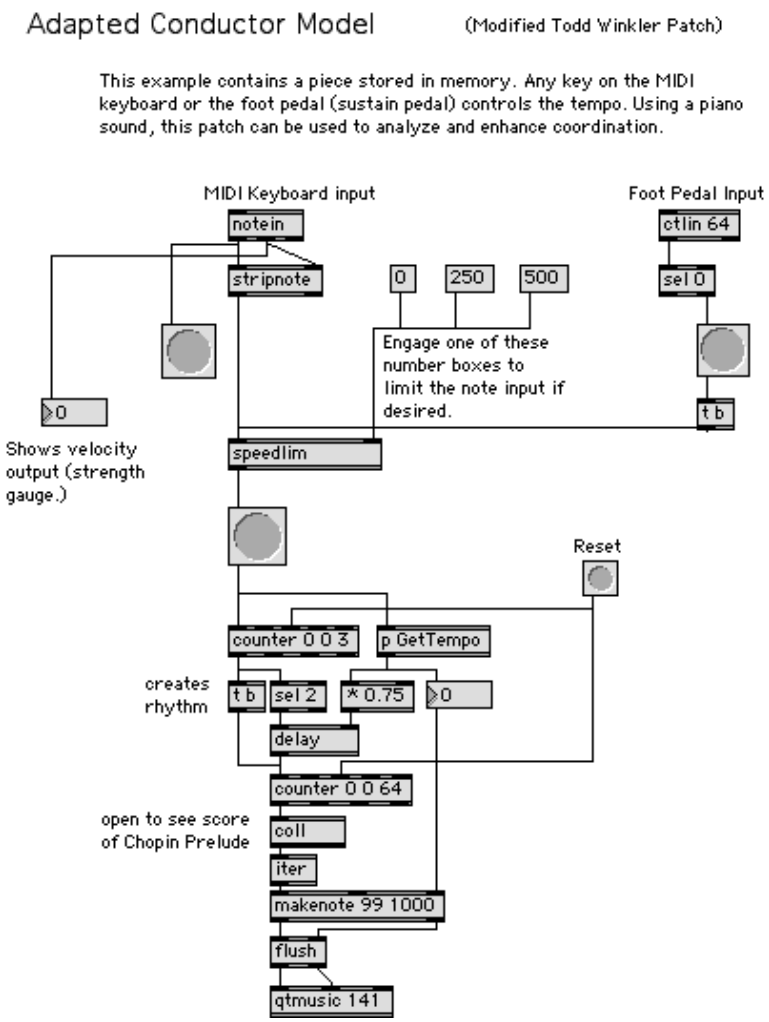


Figure 4-4

Adapted Conductor Model Patch

Enables choice between keyboard or sustain pedal, and speed limitation

In addition to the choice of using either the keyboard or the sustain pedal to generate tempo and "conduct" the flow of the piece, three speed limitation settings have been added to give the therapist control over just how fast the piece can be played. Let's assume a client has never heard this

piece, and therefore has no idea how it is supposed to sound. Furthermore, the client may not have the physical ability to create a smooth tempo of any kind. By using the **speedlim** object, the trigger rate of input can be controlled, thereby enabling greater management over the musical output. By hearing how steady the piece is supposed to sound, the client has a goal to attain.

The **speedlim** object in the **Adapted Conductor Model** functions like training wheels on a child's bicycle. When a child learns to ride a bike, his or her parent will gradually adjust the training wheels to be further apart until the child no longer needs them to maintain balance and control. Likewise, the three settings of the **speedlim** object can be adjusted in much the same manner. The incoming notes can be limited to two per second, (the 500 setting) four per second, (the 250 setting) or no speed limitation (the 0 setting.) While the prelude's normal tempo is much slower than the maximum setting of the **speedlim** object in this patch, allowing the client to play the piece more rapidly grants more of the expressive freedom healthy musician's enjoy.

Dr. Ramsey's feedback on the **Adapted Conductor Model** was positive. He approved of using minimal physical input to attain maximum musical output by restricting the composer's input to tempo. The flexibility Max offers in that virtually every parameter of every patch is adjustable, gives a system like this a great advantage over store-bought hardware, for

which adjustment parameters are limited. (This is a nod to the original purpose for which Miller Puckett created Max – to control the 4X synthesizer.) For practical therapy application, however, even though the **Adapted Conductor Model** is a good start and proves Max has potential as a therapeutic tool, Dr. Ramsey wanted me to explore the addition of interactivity that would maintain a client's attention via a call and response method.

Revised Adapted Conductor Model Patch

Fortunately, since the basic design of the **Adapted Conductor Model** was a good foundation, the next logical step would be to build upon it. In collaboration with my colleague, Stephen B. Ward, together we added the additional interactive functionality requested by Dr. Ramsey to the **Adapted Conductor Model**.

As seen in **Figure 4-5**, the **Revised Adapted Conductor Model** contains enhanced interactivity for both therapist and client. Notice the LED meter on the bottom right of the patch. This meter is colored with green, yellow, and red LED displays by which a therapist can analyze the steadiness of a client's input at a glance in real time. Green LEDs indicate very steady control, yellow LEDs indicate less control, and red indicate the least control.

The tolerance level (sensitivity) is adjustable so that this patch will be useful for a range of clients with various abilities.

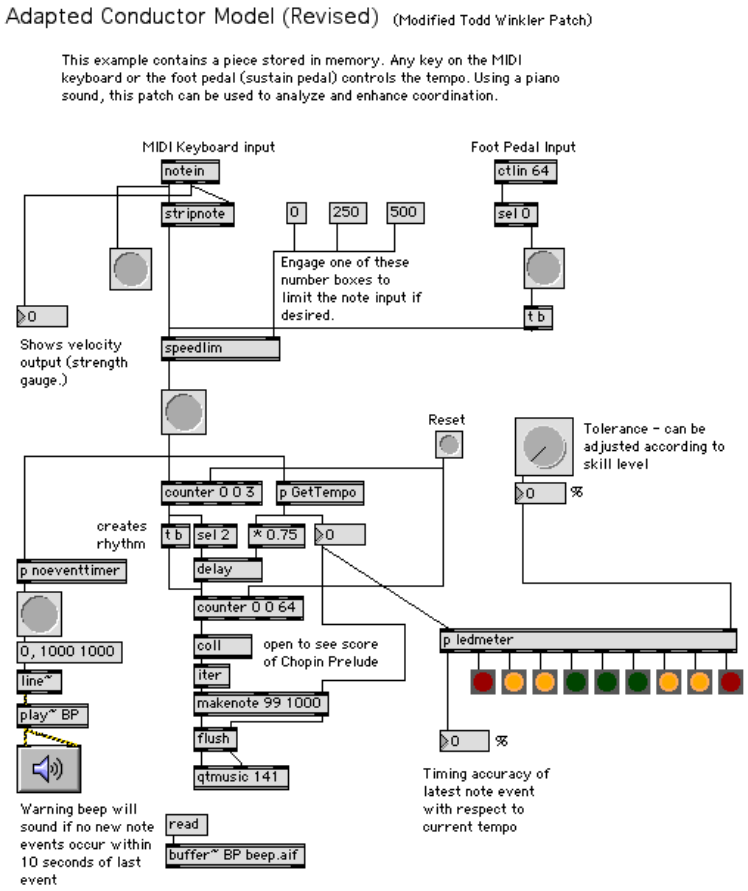


Figure 4-5
Revised Adapted Conductor Model Patch with Interactivity Features

This information can be very useful when gauging physical progress. While strength is an obvious physical trait, control is subtler. By measuring the input events and displaying them in percentages, the therapist gains insight as to how much control the client is wielding when making music with this patch.

In order to create a useable LED display, subpatches were required to handle the necessary calculations of the incoming note events from the client composer. The **LED Meter** subpatch takes in each note event, and essentially quantizes the events by recognizing their occurrence over time in relation the previous note event and the current tempo. The output is sent to the colored LED objects, giving the therapist real-time analysis (in percentage) of each new note event's timing accuracy in relation to the previous one.

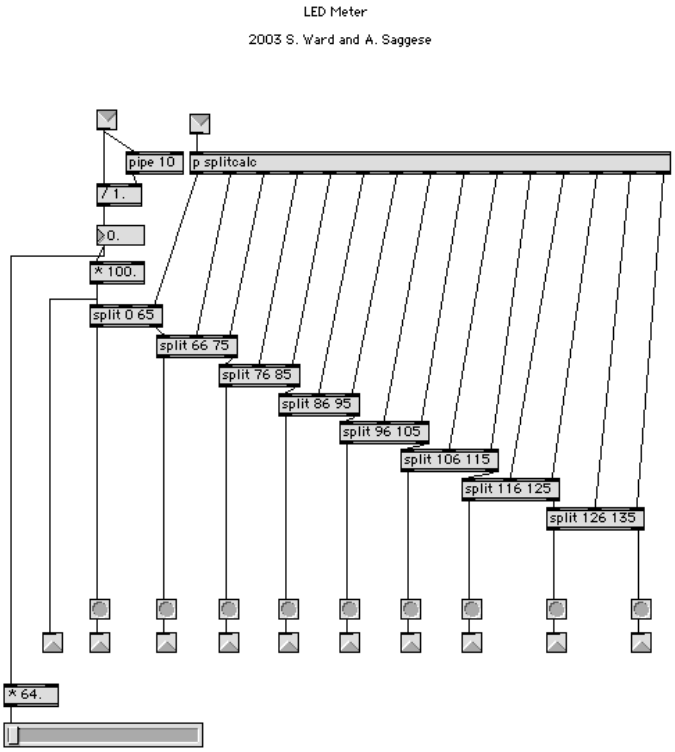


Figure 4-6
LED Meter Subpatch for Adapted Conductor Model

Figure 4-6 and **Figure 4-7** are the subpatches that reside within the Adapted Conductor model from **Figure 4-5**. The **SplitCalc** subpatch allows

the **LED Meter** subpatch to display the fairly complex analysis of very simple client input.

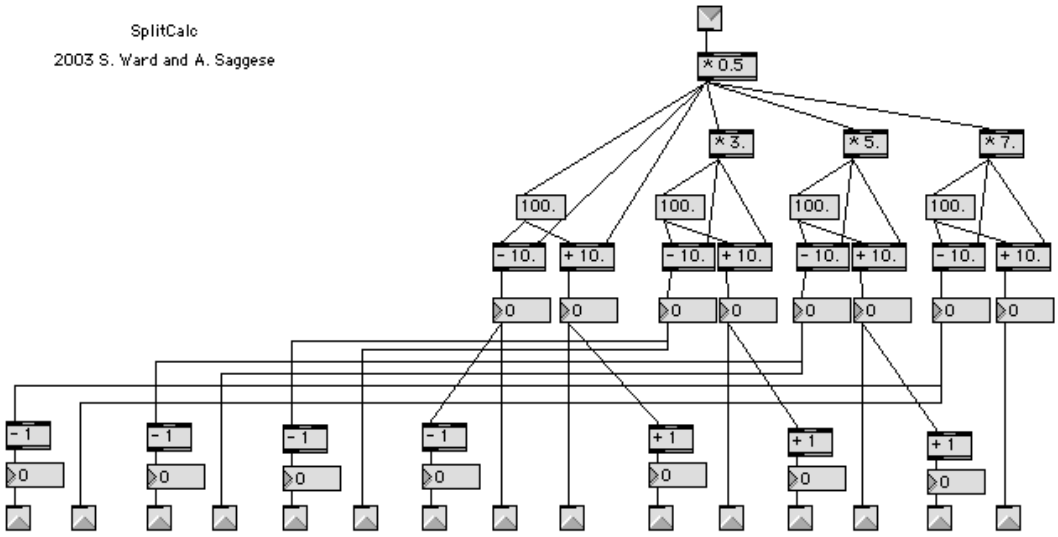


Figure 4-7
SplitCalc Subpatch within LED Subpatch

SplitCalc generates the calculations needed to feed output to the **LED Meter** as adjusted by the **dial** object, which resides in the main window of the **Revised Adapted Conductor Model** patch. A therapist would need the option to vary the sensitivity of **LED Meter's** readings according to the physical ability of a particular client. Flexibility in this manner enables a therapist to chart the progress of a client based on the client's own ability, and also against other clients with similar profiles.

This enhanced analysis is valuable, but only if a client maintains input for the length of the Chopin prelude. Another of Dr. Ramsey's requests for interactivity was to implement some type of call and response feature to the

Adapted Conductor Model. It is common for neurologically challenged clients to have a great deal of difficulty maintaining interest in a given task, especially in the early stages of therapy. As Dr. Ramsey pointed out, even in communication between normally developed people, an action or sound is needed to restore attention to a conversation if a party becomes distracted. Naturally, therapists must utilize various alert cues to sustain a client's attention, as maintaining concentration can often be quite difficult for many clients.

In order to address this need in the **Revised Adapted Conductor Model**, the MSP extension of Max was employed to play an audio file that resembles an alert cue suggestive of an alarm clock. If a client goes longer than 10 seconds from the last input without entering a new note event, the **beep.aif** sound file plays to direct the client's attention back to the task of conducting the Chopin prelude. This is achieved via the **No Event Timer** subpatch as seen in **Figure 4-8.**

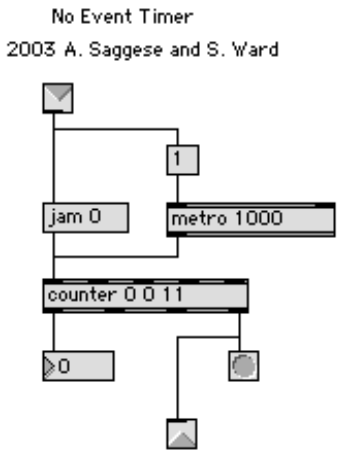


Figure 4-8
No Event Timer Subpatch within Adapted Conductor Model

The additions of the **LED Meter**, **SplitCalc**, and **No Event Timer** subpatches fundamentally satisfy Dr. Ramsey's request for enhanced interactivity features. Thoroughly testing the **Revised Adapted Conductor** in actual therapy, however, is unfortunately beyond the scope of this project.

KJ - The Keyboard DJ Patch

Delving further into the concept of using minimal input and generating maximum musical output, I began to experiment more with the MSP extension of Max in order to work with audio samples. During the sessions spent with Stephen B. Ward working on the patches for the **Revised Adapted Conductor Model**, Steve presented an idea for playing back drum samples in Max/MSP using the computer keyboard.

Taking this idea in a different direction, **KJ – The Keyboard DJ** patch (**Figure 4-9)** was designed for operation with the portable system (**Figure I-1)** used for all of the major work on this thesis project.

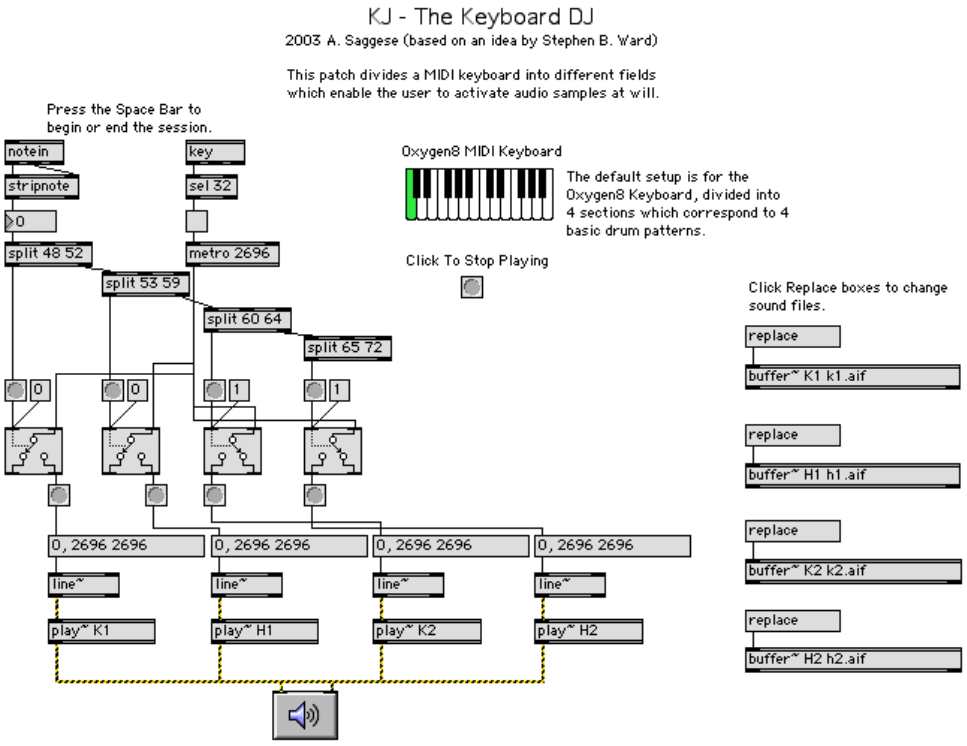


Figure 4-9

KJ – The Keyboard DJ Patch

KJ is a basic audio sample playback machine that employs one-note triggers to engage four audio samples stored within the patch. This patch comes embedded with four drum patterns – two kick/snare patterns, and two hi-hat patterns.

The interactivity of **KJ** is a different approach from the previous patches used in this thesis project. While the **Revised Adapted Conductor Model** focuses on interactivity with the hardware for both therapist and client, **KJ's** aim is to be interactive in a group therapy scenario, where multiple client composers are interacting with each other through jamming. More specifically, **KJ** is suited toward an adult client with healthy cognitive

skills, as opposed to an autistic child. Since drums have such directional power over group improvisational music making, using drum patterns for the default sounds was a logical choice. The client composer using **KJ** running on the portable system has only to strike one key to engage any one of the four drum pattern samples, and can control the feel of the jam session simply by changing patterns. With very simple input, a client composer can start, stop, and change the feel of a jam session even with just these four simple patterns.

When **KJ** is activated, the Oxygen8 Keyboard is virtually divided by the **split** object into four sections from left to right. Keys corresponding to note values 48-52 control the first kick/snare pattern, and keys corresponding to note values 53-59 control the first hi-hat pattern. This is duplicated across the remainder of the keyboard for the other two sample patterns. A client composer need only strike within a range of keys to play a sample, so pinpoint accuracy is not required to make music with **KJ**.

Granted, **KJ** is not nearly as powerful as the hardware drum machines available these days, but this patch's simplicity of operation is its strength. **KJ** becomes even more intriguing when thought of as being coupled with an unorthodox instrument interface. Imagine a MIDI interface embedded in a rubber mat the size of a small area rug, divided into four fields. Clients could engage the fields by moving over them in a wheelchair or by stepping on them. As with all patches in this thesis project, the Oxygen8 interface is to

be thought of both for practical use and merely as an example of a working interface that could be changed in favor of an unorthodox MIDI interface.

Pressing the computer keyboard's spacebar activates **KJ**. The **play~** object looks to the **buffer~** object for the audio samples to be played, but the **Ggate** object is what makes the samples musically viable in **KJ** from a performance perspective. Once the spacebar is pressed and **KJ** is activated, a **metro** object feeds the **Ggate** objects the 89-bpm tempo, which matches the drum samples' native tempo. This locks the samples in time, preventing them from activating out of sync if a client's note events are too far off beat. This is built in to the design so that a group therapy jam session can be prolonged without relying on a high level of physical skill on the part of the client playing **KJ**. Additionally, the **Ggate** objects are wired so that a key on the Oxygen8 can start or stop a given pattern.

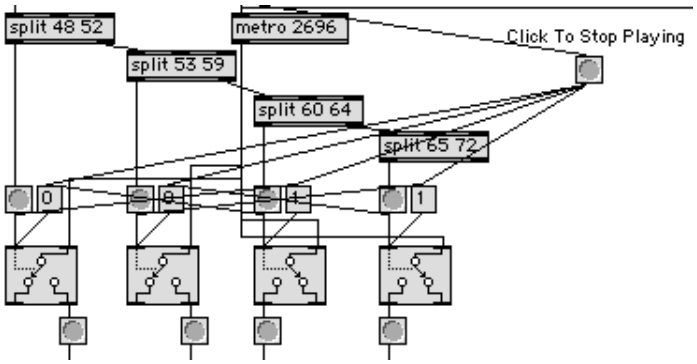


Figure 4-10

Close-up of KJ's Wiring Normally Hidden From View
Note the Four **Ggate** Object Switches in Default (Off) Position

When a different kick/snare or hi-hat pattern key is activated, the current sample will be replaced by the alternate pattern that corresponds to the latest key pressed. This translates into very smooth drumming by effectively disabling any overlapping *and* out-of-sync playback.

The application scenarios for **KJ** are wide. For example, **KJ** could be used with older clients who are faced with disabilities after having lived a healthy childhood. For someone who has lost a significant measure of physical ability, the power to control the pace of a jam session with **KJ** addresses the objectives of music therapy in conjunction with Dr. Ramsey's clinical approach:

> "In a usual conversation people negotiate the use of time. There is a shared body of knowledge among people who speak the same language that governs how long a person speaks and how a person gives up the speaking floor. Vocal dynamics, body language, facial expressions, and many other forms of expression are employed in most conversations and give deep texture and meaning to our words…So when a patient comes to me after losing the ability to produce vocal sounds, I instantly restore an 'essential human experience' by giving them an instrument that they can control. They are instantly restored to an experience related to 'real time' communications by manipulating the dynamics and time and melody of musical improvisations." (Ramsey via email, 2003)

KJ attempts to do the same through a basic interface that requires minimal physical input to operate. It is not an attempt to give a client the illusion of playing a drum kit. Rather, **KJ** aims to restore the ability to direct the "conversation" of a group therapy jam session.

Conclusions

Modern music technology is not commonly being exploited as a music therapy agent. From the perspective of this music technology student, the absence of a dynamic, mutually dependent working relationship between music therapy and music technology is a disservice not only to members of these respective fields, but more importantly to the clients in position to benefit from music therapy.

Understanding that music technology has given birth in recent years to countless intuitive electronic music interfaces, protocols, software, innovative children's instruments, etc., it is only logical that this creative force be tapped to enhance music therapy treatment. Examples of this readily available technology were brought together in the form of the portable system that was used for this project. The iBook, Oxygen8, and Max/MSP software offer countless configurations that enable this system to be used in a variety of therapeutic applications. Max/MSP patches, like the ones adapted and written specifically for this project, represent just some of the possible approaches that can be taken to create useful music therapy tools. Skilled programmers and composers have the tools and ability to create custom music therapy software and interfaces with great efficiency these

days. If music therapists who are comfortable with MIDI technology begin to work closely with highly skilled programmers, the field of music therapy will undoubtedly enjoy greater success in its endeavors, as therapists will be better equipped to meet client needs.

I submit that universities offering degrees in both music therapy and music technology should actively endorse the practice of students enrolling in seminars in each other's field. As stated in the introduction, the seeds of this project were planted several semesters ago when I took Psychology of Music as an elective course. If more technology and therapy majors are encouraged to take such introductory elective courses in each other's field on the undergraduate and graduate levels, a natural relationship between future professionals in both fields will result.

Dr. Ramsey's participation and feedback were invaluable to this project. Without his perspective, there would not have been an authoritative direction for the Max/MSP programming. Unfortunately, due to mitigating circumstances, he was not always available for consultation. His association with this project was purely voluntary, and sincerely appreciated. The same applies to Stephen B. Ward. His help and guidance were necessary for the original Max/MSP programming featured in this project.

It would have been preferable to test these patches in therapy situations or at least present them to other therapists. Understandably, such

experimentation and participation from others would have to be spearheaded by qualified personnel with a professionally recognized purpose. It is hoped that this thesis will inspire music technology and music therapy professionals to continue building upon the ideas and philosophy behind this work.

This thesis aimed to achieve large goals as an educational vehicle. From my perspective alone, it entailed learning about music therapy and greatly expanding my knowledge and skills for working with Max/MSP. I am not a therapist, nor am I an expert programmer. My experience should be viewed as a microcosm of the experiences music therapists and music technologists will have, should they answer the call to work together. There is much to be gained, and the benefits of cooperative research are too great to ignore.

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A Day's Work Music Education and Music Therapy Instruments and Products

- http://www.adaysworkmusiceducation.com

Cycling74 – Publishers of **Max/MSP**

- http://www.cycling74.com/

Institute for Music and Neurologic Function – an affiliate of the Beth Abraham Family of Health Services

- http://www.bethabe.org/index1.html

Max43TutorialsAndTopics.pdf

- http://www.cycling74.com/products/dlmaxmspmac.html#four-two

Max/MSP FAQ

- http://www.cycling74.com/support/questionsmsp.html

The Nordoff-Robbins Center for Music Therapy

- http://www.nyu.edu/education/music/nrobbins/index.html

Tod Machover

- http://web.media.mit.edu/~tod/

Toy Symphony

- http://www.toysymphony.net/
- http://www.media.mit.edu/hyperins/ToySymphony/musictoysbb.html
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Qtmusic object download

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APPENDIX

Glossary of Selected Technical Terms

LED - Light Emitting Diode. Represented by a color-assignable graphic image in Max.

Max/MSP - Object-oriented MIDI and digital audio synthesis software.

MIDI - Music Instrument Digital Interface. Standard serial protocol that enables physical connection and programming control of electronic synthesizers, controllers, effects units, and computer systems. Uses two 5-pin MIDI cables between each device for bi-directional communication.

MIDI Interface - Device that enables one or more MIDI-enabled units to be connected to a computer. MIDI interfaces use standard 5-pin MIDI cables to connect with MIDI units, and use USB, parallel, or standard serial connections to connect to computers.

MIDI I/O - MIDI in and out connection. Refers to physical connectors and electronic (virtual) connectors.

Patch - Max program.

Sample - Small audio recording stored as a file on a computer hard drive. Can be manipulated in a host of music-making applications.

Subpatch - Smaller program that resides within a larger Max patch.

USB - Universal Serial Bus. Standard bi-directional serial protocol for computer hardware. Enables two-way serial communication between computer and third-party external hardware with a single physical cable connection between computer and USB-enabled device.

Oxygen8 Specifications

Keyboard Type	25 dynamic key
Simultaneous Output	10 note (reverse priority)
Control Switches	MIDI Channel Reset Octave -2,-1,center ,+1,+2 Program Change CC-00/CC-32 (GS Bank Selection) CC-No.(Generic CC Assignment) CC-Data Data Entry Velocity Assignment Data Entry Reverb Send Level Assignment Data Entry Chorus Send Level Assignment Pan Pot Assignment (CC-10) Volume Assignment (CC-07) Numerical Keys (x 10) Enter Cancel Pitch Bender Wheel Modulation Wheel Data Entry Slider
Rear Terminals	MIDI Out jacks (Kybd &Comptr -DIN) Sustain jack (1/4") USB port (to Comptr -pwr &MIDI) Power Select switch Power jack
Display Type	7-segment LED (x 3)
Dimensions	42 x 23.7 x 7.62 (cm)
Weight	1.4 kg
Power Source Options	External supply (9VDC,500ma) USB Battery (6 AA)

Reprinted from Oxygen8 Manual
(Complete manual available for download at www.m-audio.com)

Oxygen8 MIDI Implementation Chart

Oxygen 8 Version:1.0

Function	Transmitted	Recognized	Remarks
Basic Channel			
Default	1	x	
Changed	1-16	x	
Mode			
Default	Mode 3	x	
Messages	x	x	
Altered	**********	x	
Note Number 12-108	x		With Octave Change
True Voice	**********	x	
Velocity			
Note ON	o	x	
Note OFF	x	x	
After Touch			
Key 's	x	x	
Ch 's	x	x	
Pitch Bender	o	x	
Control Change	o	x	
Prog Change			
:True #	1-128	x	
:CC-00,	**********	x	
:CC-32	0-127	x	
System Exclusive	x	x	
System Common			
:Song Pos	x	x	
:Song Sel	x	x	
:Tune	x	x	
System Real Time			
:Clock	x	x	
:Commands	x	x	
Aux Message			
:Local ON/OFF	x	x	
:All Notes OFF	o	x	Send with Reset
:Active Sense	o	x	
:Reset	o	x	Send with Reset
Notes:			o=Yes,x=No

Reprinted from Oxygen8 Manual
(Complete manual available for download at www.m-audio.com)

Oxygen8 MIDI Controller Chart

Number	Definition	Parameter
0	Bank Select	0-127
1	Modulation Wheel	0-127
2	Breath Control	0-127
3	Undefined	0-127
4	Foot Controller	0-127
5	Portamento Time	0-127
6	Data Entry	0-127
7	Channel Volume	0-127
8	Balance	0-127
9	Undefined	0-127
10	Pan	0-127
11	Expression Controller	0-127
12	Effect Control 1	0-127
13	Effect Control 2	0-127
14	Undefined	0-127
15	Undefined	0-127
16	General Purpose Controller #1	0-127
17	General Purpose Controller #2	0-127
18	General Purpose Controller #3	0-127
19	General Purpose Controller #4	0-127
20-31	Undefined	0-127
32-63	LSB Controllers (0~31)	0-127
64	Damper Pedal on/off (sustain)	0-127
65	Portamento on/off	<63=off;>64=on
66	Sustenuto on/off	<63=off;>64=on
67	Soft Pedal on/off	<63=off;>64=on
68	Legato Footswitch	<63=off;>64=on
69	Hold 2	<63=off;>64=on
70	Sound Controller 1	0-127
71	Sound Controller 2 (Resonance)	0-127
72	Sound Controller 3 (Release Time)	0-127
73	Sound Controller 4 (Attack Time)	0-127
74	Sound Controller 5 (Cutoff)	0-127
75	Sound Controller 6 (Decay Time)	0-127
76	Sound Controller 7 (Vibrato Rate)	0-127
77	Sound Controller 8 (Vibrato Depth)	0-127
78	Sound Controller 9 (Vibrato Delay)	0-127
79	Sound Controller 10	0-127
80	General Purpose Controller #5	0-127
81	General Purpose Controller #6	0-127
82	General Purpose Controller #7	0-127
83	General Purpose Controller #8	0-127
84	Portamento Control	0-127
85-90	Undefined	0-127
91	Effects 1 Depth (Reverb Send Level)	0-127

92	Effects 2 Depth (Tremolo Depth)	0-127
93	Effects 3 Depth (Chorus Send Level)	0-127
94	Effects 4 Depth (Celeste Depth)	0-127
95	Effects 5 Depth (Phaser Depth)	0-127
96	Data Entry +1	n/a
97	Data Entry -1	n/a
98	Non-Registered Parameter Number LSB	0-127
99	Non-Registered Parameter Number MSB	0-127
100	Register Parameter Number LSB	0-127
101	Register Parameter Number MSB	0-127
102-119	Undefined	?
120	All Sound Off	0
121	Reset All Controllers	0
122	Local Controller on/off	0=off;127=on
123	All notes off	0
124	Omni mode off (+all notes off)	0
125	Omni mode on (+all notes off)	0
126	Monophonic Mode	0-16
127	Polyphonic Mode	0

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