UNIVERSITY OF CALGARY

Child Voice: An Interactive Electroacoustic Composition for Soprano and Computer-Generated Soundfiles with Live Digital Signal Processing

by

Patricia Lynn Dirks

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF MUSIC

DEPARTMENT OF MUSIC

CALGARY, ALBERTA
AUGUST, 1999

ABSTRACT

Child Voice, is an interactive electroacoustic composition for soprano and computer-generated soundfiles with live digital signal processing. The work *Child Voice* is a musical depiction of how language develops in children, and it explores the range of a toddler's vocal communication from first utterances to expressions of complete ideas and short phrases. The interactive environment created for this work enables a live performer to trigger soundfiles and sound processing algorithms, adding a human touch to the technology while simultaneously creating sonic possibilities previously not available in a live performance context. The duration is approximately 15 minutes.

This composition is an attempt to express a child's progression of language through seven sections. The main themes of the sections are as follows; introductory, vowels, consonants, imitation through improvisation, dialogue, a lullaby and concluding material. The text for this work was taken from various nursery rhymes, children's poetry, and selections from William Blake's "Songs of Innocence and Experience." *Child Voice* employs voice synthesis using vowel and consonant sounds to create instrumental timbres through the manipulation of audio samples both previously recorded and in real time. Editing and transformation of the audio files was accomplished through various techniques such as pitch shifting, time expansion and compression, filtering, spatialization, and mixing using computer software Cecilia, MAX/MSP, Pro Tools, and Sound Effects. An analytic paper is included which discusses the musical and interactive materials along with a CD-ROM containing the computer program used in performance and the completed soundfiles.

ACKNOWLEDGEMENTS

First I wish to extend a cherished thank you to my husband Philip, whose warm words of encouragement and patience have made this thesis possible. His constant emotional support helped me to keep going through the most stressful of times. I have greatly appreciated Philip's insightful advise and input. Without his assistance, compiling such a substantial collection of recordings of our daughter Sarah would have been unfathomable.

Sincerest gratitude is extended to my thesis supervisor, Dr. David Eagle, for his support, inspiration, and sound academic judgment. His knowledgeable criticism was most helpful in allowing me to expand my compositional and programming techniques. I have truly appreciated working with him over the past few years. Warmest thanks.

Thank you to Hildegard Westerkamp for sending me a copy of her composition "Moments of Laughter." It is a wonderful heartfelt tribute to youth and truly guided my path of creativity. It was through hearing this composition that allowed me to hear my own daughter's sounds for the pure joy that they were and free the music within them.

Special gratitude is extended to Christina Willings for her wonderful voice and countless patience in performing *Child Voice* on Sunday, July 11, 1999.

To Anthony Reimer for his assistance in the preparing the final CD-ROM format of *Child Voice* . Thank you.

Most of all I am extremely grateful to my daughter Sarah, whose precious sounds have become an intricate part of this composition. Sarah has been a constant source of inspiration from her beginning and continues to intrigue and amaze me as she grows.

DEDICATION

To my dearest Sarah, may you one day experience all the joys of motherhood that you have bestowed upon me. - Thank you.

TABLE OF CONTENTS

Approval Page ii
Abstract iii
Acknowledgements iv
Dedication v
Table of Contents vi

CHILD VOICE: AN ANALYSIS 1
- Introduction 1
- Research and Analysis 2
- Musical Form 4
- Conclusion 17

CHILD VOICE: AN INTERACTIVE COMPOSITION FOR SOPRANO AND COMPUTER-GENERATED SOUNDFILES 18
- Instructions 18
  - CD-ROM Contents 18
  - Equipment Needed 18
  - System Requirements 18
  - Performance Setup 18
  - Text Sources 19
  - Notation 21
- Score 22

BIBLIOGRAPHY 37

APPENDIX A: Formal Shape 38

APPENDIX B: Analysis Graphics 39

APPENDIX C: MAX Patches 42

CHILD VOICE: AN ANALYSIS

Introduction

Child Voice is an interactive electroacoustic composition for soprano and computer-generated soundfiles with live digital signal processing. The entire piece is based on a single sound source: the vocalizations of my young daughter, Sarah. Recordings were made over a period of approximately one year, between February 1998 and March 1999, from the time she was 17 days old until 14 months old. The composition was realized at the University of Calgary Electroacoustic Music Studio and completed in July 1999.

The concept for *Child Voice* was inspired by the approaching birth of my first child. Anticipating my forthcoming child's development, I began to think about how such a small infant is able to develop so rapidly while discovering language and communication. Relating this curiosity to my previous knowledge of computers and speech synthesis, I thought it would be fascinating to attempt a similar process in an electroacoustic medium that would emulate my child's development. Through further compositional studies in the area of electroacoustic music, my interest was extended to exploring the technical possibilities of computer sound synthesis and audio manipulation of a human voice. My intention was to employ vocal synthesis that would use vowel and consonant sounds of my child as she developed vocally to create instrumental timbres, through the manipulation of audio samples both previously recorded and through live digital signal processing. The result was to create a musical depiction of how language develops in children and explore the range of a toddler's vocal communication, from first utterances to expressions of complete ideas and short phrases.

In realizing this musical depiction I envisioned a two-character interplay, one being that of the developing child and the other of the teaching and nurturing adult voice. In the composition, *Child Voice*, a computer represents the child voice while a live soprano represents the adult voice. It is important to note the soprano's role at times switches to the child's for emphasis of a vocal development that leads to imitation of sounds around them. To best realize this interplay the work presents an interactive environment created with the

computer programming language MAX [1] with MSP [2] which enables the live performer to trigger soundfiles and sound processing algorithms, adding a human touch to the technology while simultaneously creating sonic possibilities previously not available in a live performance context.

Research and Analysis

During the formation of the concept for *Child Voice* I began researching works similar in nature to what I had planned to write. The works of great interest to me included those that dealt with the voice in an electroacoustic setting such as Karlheinz Stockhausen's *Gesang der Jünglinge* [3], Luciano Berio's *Thema: Omaggio a Joyce* [4], Charles Dodge's *The Waves* [5] and Jonathan Harvey's *Mortuos Plango, Vivos Voco.*[6] I was intrigued by Berio's use of phonemes in the second movement, "O King", of his work *Sinfonia*[7] which uses only vowel phonemes from Martin Luther King's name. Canadian composer Robert Normandeau's use of a single voice to create his works such as *bédé, éclats de voix, spleen, tropes, tangram* [8] was also a fascinating source of stimulation for me. One of the most valuable works in aiding the formation of a musical composition from my daughter's various recordings was Hildegard Westerkamp's *Moments of Laughter*.[9] The biggest obstacle during the writing of this thesis composition was how I could make the extensive collection of my child's recordings into a musical creation. It was by listening to this truly inspiring work by Westerkamp that helped me to realize that a child's pure "sounds" are music within themselves.

---

[1] MAX 1.0.6-6, Opcode Systems/IRCAM, Paris, France, 1990-98.

[2] MSP, Cycling '74, San Francisco, California, 1997-99.

[3] Karlheinz Stockhausen, "Gesang der Jünglinge," on Gesang der Jünglinge, no.1 Kontakte, Deutsche Grammophon Gesellschaft, SLPM 138811, 1968.

[4] Luciano Berio, "Thema: Omaggio a Joyce," on Electronic music III, Turnabout, TV 34177, 1969.

[5] Charles Dodge, The Waves (New York: American Composers Alliance, 1984).

[6] Jonathan Harvey, "Mortuos Plango, Vivos Voco," on Computer Music Currents 5, Wergo, WER 2025-2, 1990.

[7] Luciano Berio, Sinfonia (London: Universal Edition Ltd., 1972).

[8] Robert Normandeau, Tangram, empreintes DIGITALes, IMED 9419/20-CD, 1994.

[9] Hildegard Westerkamp. "Moments of Laughter," Score, 1988, Canadian Music Centre, Mackimmie Library, University of Calgary, Alberta.

After this discovery I began to experiment with the simplest and purest sound in my daughter's collection of recordings. From these recordings I isolated five samples that were the closest sounding to the five pure Italian vowels; a, e, i, o, u. I then conducted my own analytical research to investigate the harmonic spectra of each sample. All of the samples were saved as Sound Designer II stereo soundfiles at a sampling rate of 44100 Hz and were then analyzed using the spectral analysis program AnnaLies.[10] The purpose of this investigation was to analyze the harmonic spectra in each sample and identify the formant regions (fixed frequency region within the spectrum of a particular sound).[11] The location of the formant regions are important, because that is what characterizes each sound. Voice qualities, in particular, that are associated with vowel sounds are determined by these formant frequencies.[12] I wanted to find the formant regions of each of the five samples as these regions also reinforce the harmonics in the tone of the vocal cords. This reinforcing of the harmonics is an ideal method for smoothly blending both the recorded material with the live soprano's voice. (The results of this research can be viewed as two dimensional Amplitude versus Frequency graphs in Appendix B.)

From the analysis results I correlated the frequencies of the prominent partials to the nearest pitches within the equal temperament tuning. I then decided that the formant regions of each of the vowel samples would form the basic pitch collection for the composition *Child Voice*. In sample "A" the formant region occurs at 1160 Hz. Therefore, the closest pitch to represent this region would be D6 at 1175 Hz. All calculations were based on middle C being equal to C4 and subsequently A4 being equal to 440 Hz in the equal temperament tuning system.[13] For example in sample "E" the formant region occurs at 1097 Hz, which is nearest to C#6 at 1109 Hz. In samples "I" and "O" the formant regions were nearest to B5 (988 Hz) and G4 (392 Hz) occurring at 1009 Hz and 397 Hz respectively. The formant region for sample "U"occurs at 378 Hz, which is nearest to F#4 at 370 Hz. (The formation of these analysis results are explained in detail at the end of

---

[10] AnnaLies v 4.3.1, David Hirst, La Trobe University, Australia, 1996.

[11] John Backus, The Acoustical Foundations of Music, 2d ed.,(New York:W.W. Norton and Company, 1977), 118.

[12] Ibid., 245.

[13] Ibid., 153.

Appendix B.) This results in the pitch collection of F#, G, B, C# and D which, when placed in normal order, produces the cell [0,1,5,7,8]. In the composition, *Child Voice* the inversion of this collection D, D#, F, A and A# was also used, producing the cell in prime form: [0,1,3,7,8].

Musical Form

Child Voice is a musical portrayal of a child's language development. This composition is made up of seven sections, indicated in the score by rehearsal letters A to G. The main themes of the sections are as follows: introduction, vowels, consonants, imitation through improvisation, dialogue, a lullaby, and concluding material.

The text for this work was taken from various nursery rhymes, children's poetry, and selections from William Blake's "Songs of Innocence and Experience." [14] In keeping with the light hearted nature and nurturing quality that this composition presents I selected only certain words from Blake's "A Cradle Song"[15] to be used in this work. (see Text Sources) The entire composition takes place in an electroacoustic environment with an interplay between two characters, the main character is the developing child and the secondary character is the teaching and nurturing adult voice. In *Child Voice* the computer represents the child and a live soprano represents the adult voice. As the work progresses, the two characters alternate in predominance from foreground to background.

Child Voice employs voice synthesis using vowel and consonant sounds to create instrumental timbres similar to the way that Charles Dodge created the fixed tape material in his work *The Waves,*[16] through the manipulation of previously recorded audio samples. Since *Child Voice* is an interactive work, I also extended this idea to real time digital signal processing. In real time processing a live input is fed into the computer from a microphone and sent through a series of programmed MAX effects patches which then play the sonic results. These results include elongation of the original input material through various echoes and delays, the changing of the original pitch, as well as the variation in the

---

[14] William Blake, Songs of Innocence and Experience, ed., Andrew Lincoln (Princeton: William Blake Trust/Princeton University Press, 1991).

[15] Blake, A Cradle Song, in Songs of Innocence and Experience, ed., Andrew Lincoln (Princeton: William Blake Trust/Princeton University Press, 1991), 16.

[16] Dodge.

original's rhythmic pattern. Throughout the score there are a total of 35 cues which activate the programmed MAX patches in the program *Child Voice*. The soprano triggers each event via a MIDI foot controller, resulting in either the playing of specific soundfiles or real time digital signal processing.

The opening of the composition at (0:00) is a solo soundfile (Solo #1). This section acts as an introduction, presenting manipulated vowel sounds which are later used throughout the work in various forms. All sounds in this passage were created from synthesized vocal sounds and prerecorded audio files. The basis of the opening soundfile is the formation and use of vocal sounds and phonemes. This idea of creating a texture from the smallest part of speech is similar to the way Berio composed his Sinfonia, *mov.II, "O King".* [17] In his composition only the vowel phonemes present in Martin Luther King's name were used to create the entire movement. In *Child Voice* pure Italian vowels are used to create the opening soundfile (Solo #1). This computer solo also consists of a slow progression involving processed vocal utterances that are within the background texture and not yet understandable. Over a period of two minutes these vocal interjections occur five times and can be seen in the graphic representation of the soundfile on page 1 of the score indicated by an asterisk (*) at (0:30), (1:10), (1:33) and (1:47). By the fifth time the vocal sounds occur at (1:55) they are finally revealed to be the clear sound of a child's laughter and are indicated by the label "laugh" in the graphical portion of the score.

The soundfile continues until the soprano makes her entrance at the end of section A. To enable her to begin on the starting pitch of F#4, the soundfile ends with a short descending glissando from F# to F. This presentation of the opening soprano's pitches happens twice at approximately (2:35) indicating the end of section A and the beginning of section B.

Through varying glissandi and live digital signal processing of short recorded phrases, section B is a live vocal extension of the introductory material of changing vowel sounds. It begins with the triggering of event #4, which plays a soundfile based on the vowel sound "u" (as in moon). At the same time, the soprano begins to sing at her own pace, based on the metronome marking of a quarter note equaling a value between 52 and

[17] Berio, Sinfonia.

60 beats per minute. The first sung phrase consists of a series of three smooth *piano* ascending and descending portamenti on the pure Italian vowel "u", indicated by italics in the score. This short phrase begins and eventually ends on F#4, filling the span of a major second (F4 to G4). This chromatic pitch collection of (0,1,2) comes from both the pitch set based on the formant regions and its inversion (see Research and Analysis). This chromatic cell of F, F# and G is also important as is is made up of the opening fundamental frequencies of all five samples (see Appendix B). The soprano's pitch material starting from the beginning of this section and continuing up until the first sung intonation curve (see page 24 of the score) is in E Dorian mode.

Immediately following the opening soprano's phrase is the triggering of event #5. This plays the soundfile based on the vowel sound "a" (as in raw) and 10 seconds later is programmed to fade in the soundfile "o" (as in row). Simultaneously, the soprano is singing another phrase made up of three smooth ascending and descending glissandi overtop of the changing soundfile texture, on the vowels "a" and "o". At approximately (3:00) the soprano and soundfile are both on the vowel sound of "o". While the computer continues to play the "o" soundfile the soprano performs a quick descending smooth glissando followed by a quick ascending smooth glissando on "i" (as in bee) and "e" (as in day). This leads to a long held note on B4 on the vowel "i" which the soprano dovetails with the triggering of the next cue and then remains silent until the entry of her next phrase.

At approximately (3:15) event #6 triggers a soundfile of a child's laugh, which is now played back through a live digital sound processing effects patch. While this is occurring the previously mentioned soundfile "o" is still being played and thus now becomes the background material in the electroacoustic texture. Once the laughter sound event has stopped, the soprano begins again, this time singing a phrase of two rising and falling glissandi, expanding the previous pitch collection to a tritone (C5 to F#4). It is this gesture that gives way to event #7 at approximately (3:28) with the live digital sound processing of a prerecorded child's giggling. As this processed texture begins to fade, a soundfile based on the vowel sound e is played at event #8 (3:34). The soprano now sings a series of four smooth and one sighing glissandi alternating on the vowel sounds of "e" and "o." This short passage crescendos from *mezzo piano* to *forte* ending on a sustaining pitch

of B4 on the vowel sound of "a". After a pause of two beats the soprano begins to sing an intonation curve, a fluctuating glissando following the path of the line drawn between two pitches. This intonation curve descends from C5 eventually arriving on a *piano* C#4. The soprano sings this curve with a vowel modulation (ie. a gradually changing of the shape of the oral cavity, beginning on the vowel sound "i" and ending on the vowel sound "u".) As the last held note of the intonation curve (C#4) is fading out, event #9 (4:12) is triggered playing a soundfile of various vowel sounds juxtaposed together.

An important development occurs while this vowel sound material is playing and the soprano begins singing the next three short phrases. Each phrase develops the material of the previous one by being successively quicker and containing more pitched material than the one before. The final development of each of the these phrases occurs at event #11 when the fourth phrase, sung as fast as possible on "a" and ending on a held "u", is revealed as the complete motivic theme. Not only is this fourth phrase (Sample 1) important with respect to thematic material: it is also the first time that what the soprano is singing is being recorded live by the computer. Event #11 triggers the live recording of the soprano which lasts for a period of four seconds. The newly recorded soundfile is temporarily stored in a buffer until it is later used in conjunction with live digital signal processing. (This effects processing is triggered through the MAX patch processing which is accessed through the "playbackp" MAX patch both of which are explained in detail in Appendix C.) Event #'s 12 to 14 trigger the playback of the buffer's contents combined with live processing, such as pitch change and time delay, to create a chorusing effect. This entire process of live recording of the soprano singing and altering playback of this material occurs again through event #'s 15 to 17.

Event #18 begins the transition to section C with a soundfile of a child's transformed vocal sounds. The transformation process, used in altering the original soundfile, and the soprano line of this section, emphasize the melodic and rhythmic nature of sound and text. Evidence of this approach occurs when the score indicates that part of the soprano's text within the brackets is to be silent. Unlike previous sections, the background material has now changed to new sound material that is not clearly recognizable. This results in the blurring of the listener's comprehension of what is being

sung while at the same time sparking the listener's attention. The sung text, during this transformation passage, is taken from William Blake's poem "Spring."[18] The soprano's opening two gestures after event #18 reflect the rhythmic flow of the text, "sweet and small" from this poem, sung on the vowel sounds of "a" and "u" to keep with the nature of the section. The following three notes (C#5, F#4 and G4) are sung on only the vowel components of the text, "so do you" resulting in the vowel sounds, "o","u" and "u". The next phrase, as indicated in the score, has the consonants of the text, "merry voice, infant noise" silenced. In particularly the last word of the phrase "noise" is sung on an intonation curve that gradually descends over a period of seven beats leading to a short pause before the next section begins.

In Section C the text emphasizes consonant sounds, and the music focuses on short rhythmic phrases, recording of live material and interruptions of short melodic fragments. This section begins at event #19, at approximately (6:43), with the live digital recording of the soprano performing a short passage of high and low tongue clicks over a period of four seconds. The difference between the two kinds of tongue clicks is accomplished by changing the mouth's oral cavity. High tongue clicks are made with an open mouth and the oral cavity in the shape of the vowel "a" while low tongue clicks are also made with an open mouth but this time the oral cavity is in the shape of the vowel "o". The tongue clicks are then followed by repeating decelerando notes on D5 that occurs within a period of two beats. The repeating notes are sung on the text "sweet" where the "s" is sung only at the beginning of the repeats and it is actually the "wee" that is being repeated. This gesture ends on the last note with the phoneme, "eet" taken from the word, "sweet". The opening text of this section is taken from William Blake's poem "A Cradle Song."[19] At the same time, event #20 is triggered at approximately (6:50). This event plays back the previously recorded tongue clicks, now with live digital signal processing, setting up a polyrhythm. While this processed sound is fading out, the soprano begins to sing a short melodic phrase of four notes reminiscent of the phrase recorded at event #11. While these two phrases are

[18] Blake, Spring, in Songs of Innocence and Experience, ed., Andrew Lincoln (Princeton: William Blake Trust/Princeton University Press, 1991), 23.

[19] Blake, A Cradle Song, 16.

clearly different rhythmically, they are similar melodically both in contour and pitch material (see page 4 of the score). This phrase is sung on the word "sleep" which, for emphasis of the consonant quality within words, has been divided into the phonemes "sle," "e" and "pa". The "a" was added to the end of the "p" from "sleep" as the consonant "p" itself is impossible to sing without a vowel sound following it. When this "pa" occurs at the end of "sleep" it is repeated over a period of three beats in an accelerando gesture. At the same time event #21 is triggered at approximately (7:04) which records the repeating of "pa" as Sample 4 on the pitch C5 for four seconds. At the end of the repeats (7:08), event #22 plays back Sample 4 with live digital signal processing. A dovetail between Sample 4 and the soprano occurs at the end of this event when the soprano begins the *mezzo forte* passage on the text "with soft down, sweet." The text has again been broken up for the consonant emphasis, resulting in the singing of the text as, "wi-th so-f-t do-wn swee-t" where the last "t" is sprechstimme (voiced between sung and spoken quality). This leads to event #23 at (7:22) with the recording of the sprechstimme passage on the text "sleep happy child." Keeping with the main idea of the section, the text is again divided into the following phonemes, "s-le-e-p h-ap-py ch-il-d tha(t)" where the last "t" of that is silenced as indicated in the score as it is within round brackets. This recorded passage of Sample 5 is then played back at event #24, which is triggered on the downbeat of "that" ending the sprechstimme passage.

When Sample 5 occurs, with its live digital signal processing effects, a soundfile of a chorus of child voices superimposed together is programmed to fade in underneath the foreground texture six seconds after the triggering of the event #24. This event triggers two MAX patches: one for the live processing playback as mentioned before called "playbackp" and one which causes a chain reaction of sound events entitled "chain" (both of these patches are explained in more detail in Appendix C).

While the chorus soundfile continues, the soprano sings two short phrases as fast as possible, holding the last note of each bracketed phrase for the remaining duration indicated above each. The text used now and until the end of section C is taken from the

popular nursery rhyme "What are little boys made of."[20] The soprano ends the two fast phrases with a sustaining pitch of F#4 followed by a two-beat silent pause. The next phrase is on the text "sugar and spice" which begins with a triplet eighth note figure of an augmented second interval consisting of (Eb4, F#4 and Eb4). This is the last sung material before the climax of the entire work. The term climax, in this essay, is used to identify the moment in the composition where the statement of complete words occurs.

The climax occurs at the end of section C, right after event #25 at (8:00), approximately the halfway point of the work. It occurs so early in the piece in order to indicate an upcoming change in the character of the material presented. Prior to the climax the chorus soundfile is still playing in the background while a live processed version of the recently recorded Sample 5 "sleep happy child" is triggered. The soprano then sings a phrase consisting of a descending stepwise triplet note figure, a tritone leap up, then down, a perfect fifth, and four ascending notes that span an octave (F#4 to F#5). This phrase is sung on the text, "and all things nice", again divided up into phonemes for consonant emphasis, resulting in the phrase "an-d al-l thi-ngs." The chorus soundfile begins to fade out by the time "nice" is sung at the end of the ascending phrase on F#5. It is the ending of the soundfile (Chorus) which automatically triggers the opening of the programmed gate that beings the playing of another soundfile. (This programmed gate is a part of the MAX patch "chain" previously mentioned in this section and is further explained in Appendix C.) This soundfile (Roar) contains a child saying the sound "mmm" which has been manipulated so that is becomes a loud roar.

The actual climax of the composition occurs when the playing of Sample 5 is ending, the soundfile "mmm" roar is beginning, and the soprano is singing a smooth descending *fortissimo* glissando on the G5 to C#4. This six beat glissando sung on the text is made as a vocal modulation indicated in the score by the phonemes "r" from the text "(a)re" and "m" from the text "ma(de)." While the soprano is singing, the soundfile of the "mmm" roar is repeated over and over, each time decreasing in dynamics to become the background material. The soprano is silent for a three beat pause before singing the two-

[20] Robert Southey, What are little boys made of?, in The Oxford Dictionary of Nursery Rhymes, eds. Iona and Peter Opie (Oxford: Clarendon Press, 1951), 101.

phrase melodic theme on the phoneme "ma" as the denouement away from the climax. This phrase is the main melodic theme of the composition as it returns later at section G. It was derived from the four short melodic fragments sung by the soprano before the climax (right before event #25).

Following the main melodic theme, there is a short fragment of transitional material that leads to the end of section C. This material is sung as fast as possible on the text "da da do do de de da," a nonsense phrase inspired by my daughter's vocal play of each phoneme. It is important that the climax of *Child Voice* happens right before the beginning of section D as this upcoming section is the turning point of the entire composition. An early climax prepares the listener for change which is why new musical ideas can be introduced without being obtrusive.

Section D consists of new musical ideas. Random sound events, whole words used as sung text and improvisation are used to form a microcosm of the entire composition. Within this microcosm, the computer and singer have a passage of play and imitation to simulate the idea of the adult voice teaching and the child voice learning through imitation and repetition. Progressively, a dialogue emerges between the two voices using the text from the poem "Infant Joy"[21] by William Blake. This is the first time that the computer, representing the child's voice, produces clear words that are created solely from the splicing and juxtaposition of audio recordings. The section begins with the triggering of event #26, which plays the soundfile of a child saying the following four distinct phrases: "ma ma ma ma mam, da da do, a ta da mmm, and da doe!" There is a short pause between each of the four phrases during which the soprano imitates these gestures vocally. When this soundfile ends at approximately (8:30) the MAX patch "randomp" begins to randomly play short soundfiles. The soprano begins to improvise on the four previous gestures imitated "ma ma ma ma mam," "da da do," "a ta da mmm" and "da doe!" As indicated in the score the soprano is to play with the inflection of each gesture therefore varying the character of the original soundfile played. This improvisatory section can continue indefinitely as the programming will continue until it receives the signal to end. However, it is indicated in the

---

[21] Blake, Infant Joy, in Songs of Innocence and Experience, ed., Andrew Lincoln (Princeton: William Blake Trust/Princeton University Press, 1991), 25.

score that the soprano continue for a minimum 45 seconds to an approximate maximum of a 1 minute, 30 seconds. This limited duration is important in providing a proportional weight to section D within the context of this composition.

The short soundfiles that continue to play randomly against the soprano's improvisations were created from the original soundfile played at the opening of section D. These short segments are divided into three groups from smallest to largest. The first group is made up of the smallest phonemes, such as "mam," "da" and "mmm." The second group contains longer two or three syllable gestures, such as "ma ma mam," "ta da" and "a ta da." The third and last group contains the full statements of the original gestures. Each soundfile within the first two groups is programmed to be played back randomly until either 15 or 38 random events has occurred. This specific counting of sound events is the programming that allows each group of soundfiles to play in succession. (This specific programming of the MAX patch "randomp" previously mentioned in this section is explained further in Appendix C.) The results of this programming is a microcosm of the entire composition, a child's vocal development, from the smallest vocal sounds to complete words and phrases.

The improvisatory section ends at event #27, which sends a command to end the repeating of the "mmm" roar soundfile. In addition, as the last repeat of the "mmm" roar is ending, event #27 triggers the playing of the soundfile "da doe!" and begins playing of the second solo soundfile that occurs in *Child Voice*. All of this programming occurs within the MAX patch entitled, "chain." (see Appendix C) The solo soundfile that ends section D combines the previous child's gestures and uses them to develop a small motive over a period of sixty seconds. In this soundfile (Solo #2) gestures from the original randomly played material, such as "ma ma ma" and "da da do," have now been elongated by four times original length through a granular synthesis process. This time expansion method was performed using the computer software environment for digital sound processing and Csound programming, Cecilia.[22] To provide contrast to the previous randomly played gestures, a sustaining vowel sound occurs to give the listener a break from

[22] Cecilia 2.0.2 for MacOS, Alexandre Burton and Jean Piché, Université de Montréal, Quebec, 1995-98.

the unexpected. It is this contrast that is used in creating a relaxing atmosphere as well as setting up a suspended sense of time for the listener. For the first time, sung pitched material is introduced by the child's voice within the solo soundfile (Solo #2). The pitched material is then transposed to create certain notes that develop as fragments of a specific motive. This motive is finally revealed at the end of the tape solo as a descending four note phrase of A, G#, E and F#. The last note of this motive (F#) is sustained by a combination of delays and echoing effects processing. The pitch of F# is used here, as it was at the beginning of section B, to signal the introduction of new musical materials. It is this sustained note that allows the soprano to find her opening pitch for the next section: (C#4) a perfect fifth above.

Section E begins at approximately (11:00) with the triggering of event #28 which plays the soundfile of a child talking. Throughout the section melodic ideas are presented, longer lyrical phrases occur, the four note descending motive from the solo soundfile in section D appears again and for the first time the text is heard as complete words and phrases. In the opening of this section the text comes from Blake's "Infant Joy."[23] As well, the opening soundfile contains words and short phrases from this poem spoken in a child's voice. All the words in this soundfile (Talking #1) were created through cutting, splicing and reassembling existing recorded material consisting of simple phonemes and vowel sounds. Most of the editing techniques were performed using the sound editing software, Sound Effects.[24] The remainder of the editing and reorganizing of the sound material was completed using the audio production software, Pro Tools.[25]

It is the soundfile (Talking #1) that then acts as the basis for a conversation to emerge. The soprano takes on the questioning and commenting role while the computer's fixed soundfile takes the role of answer and statement. For example, the first word heard at event #28 is "I". The sopranos response is a sung question, "I?", a statement, "I" followed by another question, "you?" This dialogue continues back and forth with the soprano singing short melodic and responsive phrases. The computer repeats the word "I" a total of nine times each with a slightly different inflection and dynamic, thus emphasizing

[23] Blake, Infant Joy, 25.

[24] Sound Effects version 0.9.2, Alberto Ricci, Torino, Italy, 1993-94.

[25] Pro Tools Software 3.4-4.2, Digidesign Inc., Palo Alto, California, 1997.

the way a child plays with a new word once she has mastered saying it correctly.

Following this repetition comes the phrase "I no name," which is repeated twice. The sopranos sung response is "sweet joy," "what shall I call thee?" and "what name?" Since the fixed soundfile does not answer right away the soprano continues to name the child by singing the phrase, "sweet joy I call thee." The computer then concurs with this naming by uttering the statement, "j-j-j-joy, joy, name, joy my name." It is then revealed by the soprano that the infant "sweet joy" is "but two days old," bringing to light the imaginary sound world in which this conversation is being created. The four note descending motive stated at the end of the solo soundfile in section D (Solo #2) appears within these short phrases a total of three times before event #29 is triggered. Two of these motives occur on the same text and pitches, differing only in dynamics. The first statement of this motive occurs right after the opening two questions, as a commentary to the child herself on "pretty joy" with the pitch material Eb5, D5, Bb4 and C5. However, the second time the same motive is heard in section E, it is with different text and appears as an incomplete three-note phrase, part of a five note phrase on the text "sweet joy I call thee," having only the opening three pitches in common (Eb5, D5 and Bb4). The third occurrence is on the same text and pitches as the first occurrence on "pretty joy" now sung quietly as would be a personal comment to oneself.

At approximately (11:40) event #29 is triggered, which records the soprano singing the playful phrase on the text "pretty joy, but two days old" (Sample 6). Immediately following, event #30 is triggered which produces two separate events. The first event is the playing back of Sample 6 in delayed imitation. The MAX patch "playback2" changes the pitch of the original sample recorded playing it back six times on the starting pitches Eb5, Bb4, D5, F5, Bb5 and G5 (see Appendix C). The next sound occurrence that event #30 also controls is the entry of a soundfile (Talking #2), which contains more text spoken in a child's voice, eight seconds after it is initially activated. The computer as the developing child has now reached the point of talking in complete ideas. Therefore the phrase "I happy am" occurs 10 times, acting as the background texture to the sopranos foreground material. The soprano's text now, for the second part of this section, begins with Blake's "A Cradle

Song"[26] and ends with the text from his poem "Infant Joy."[27] The soprano begins singing a flowing, legato section immediately following the soundfile (Talking #2) entry. This expressive passage is sung by the soprano, in the role of the adult voice, and expresses her thoughts and hopes she wishes to bestow upon her "happy" child. To end this flowing passage the soprano sings the phrase "sweet joy befall thee" on triplet eighth notes, followed by two eighth notes and a group of triplet eighth notes. This leads to the rising and falling glissando on the vowel, "a" after which event #31 is triggered, playing the third solo soundfile (Solo #3) within *Child Voice*. The opening of this soundfile (Solo #3) features the sounds of a newborn baby crying. It is after this introduction that the soprano sings two phrases on the text, "I sing the while." The gesture of the adult voice singing to the crying child conjures up ideas of a mother singing a lullaby to soothe her dear baby's tears and thus, as the soundfile continues, the sounds of crying turn slowly to that of a child's tender coos and soft breathing. This calm ending indicates the end of the section and at the same time, sets up the smooth progression to the actual singing of lullaby material that occurs in the next section.

Section F is a sung lullaby on the text from the children's poem "Golden Slumbers"[28] by Thomas Dekker. In this section (as in the opening of section B), the soprano begins to sing at her own pace, based on the score indicated metronome marking of a dotted quarter note equaling a value between 42 and 52 beats per minute. The section opens with the triggering of event 32, which opens the live digital signal processing MAX patch "livepro." This patch gradually fades in, records whatever the soprano sings as a live signal input, passes it through a series of delays, and outputs the sonic results. This processed output forms a pulse which then sets up the tempo that the soprano is to follow for the remainder of this section. While there exists a melody commonly associated with the text of "Golden Slumbers," (found in various children's music books[29]), the lullaby melody that appears in *Child Voice* was freely composed based on the rhythmic and melodic

[26] Blake, A Cradle Song, 16.

[27] ____ , Infant Joy, 25.

[28] Thomas Dekker, Golden Slumbers, in The Oxford Book of Children's Verse, eds. Iona and Peter Opie (Oxford: Oxford University Press, 1973), 17.

[29] Carey Blyton, ed., Golden Slumbers in The Faber Book of Nursery Songs (London: Faber and Faber Limited, 1968), 34.

patterns of other popular lullabies. In this section the soprano sings longer phrases. Following the original order of the poem itself, as it appears in the Text Sources of this essay, the soprano sings two four-beat phrases followed by an extended phrase of ten beats and completing the section with two four-beat phrases. This entire section is in E Dorian mode reminiscent of section B. This section ends after the last repeat of "rock them, rock them lullaby" is sung and the resonance from the live processing results has faded to silence.

Section G begins with the triggering of event #33 at approximately (14:15). For this section the soprano's sung material is considered to be the live signal input (similar to section F) and is passed through various delays, and outputs the live digital signal results (see Appendix C). The soprano sets the tempo that is indicated in the score as a quarter note equal to 52 beats per minute. As the soprano's live input is processed, a pulse is established in the live processing to which the soprano adjusts her tempo. The sung melody comes from the main melodic theme that was established at the end of section C, right after the climax (see page 7 of the score, third stanza). When this main melodic idea first appeared it was in two four-beat phrases. In section G the entire theme is stated at the beginning of the section as a single eight-beat phrase. This melodic theme then occurs twice more for a total of three times, each consisting of an eight-beat phrase. The entire statement of the melody appears with opening ascending pitches followed by the descending pitches forming an arch shape. The third and last phrase of the melodic theme appears as the original minus the last pitch. After this eight-beat phrase event #34 is triggered, giving the soprano the last pitch to be sung as the soundfile of vowel sounds plays the opening pitches of F and G#. The soprano then sings her last pitch of G#4 on the vowel sounds, "a," "o" and "u" blending with the soundfile's pitch material. While the soprano is fading out to a silent pause, the soundfile material becomes the foreground material. The entire composition ends with a vowel-modulation soundfile that is reminiscent of the opening solo introduction, fading out peacefully to what seems to be a calm ending. Just then a child's laughter emerges at approximately (14:45) and completes the work. Once the resonance from both the soprano and soundfile have faded to silence, event #35 at approximately (15:30) is triggered, resetting all values and ending the program *Child Voice*.

Conclusion

Due to its delicate blending of sound materials, *Child Voice* is an important addition to the repertoire of compositions that employ both interactive aspects and live digital signal processing. It is a composition that is clearly based on a single sound source: a child's vocalizations. The harmonic content of the soprano's vocal line in *Child Voice* mixes well with the electroacoustic material presented in the soundfiles due to the incorporation of the results of the harmonic analysis of the original recorded soundfiles. Overall, the composition *Child Voice* is celebration of learning and a tribute to my daughter, Sarah's pure joy and elation of life.

CHILD VOICE: AN INTERACTIVE ELECTROACOUSTIC COMPOSITION FOR SOPRANO AND COMPUTER-GENERATED SOUNDFILES WITH LIVE DIGITAL SIGNAL PROCESSING

Instructions

Before launching the program *Child Voice* it is important to read the READ ME file contained on the CD-ROM. This gives a more detailed explanation of the performance setup and special instructions depending on the type of computer equipment and software you will be using. In order to perform *Child Voice* double click on the *Child Voice* icon to open up the application MaxMSPPlay PPC3.5.9 and the necessary MAX patch. The duration is approximately 15 minutes.

CD-ROM Contents

- an audio track of a workshop performance of *Child Voice,* with soprano Christina Willings, recorded on July 11, 1999, at the University of Calgary.
- the computer programmed MAX patch, *Child Voice* and accompanying soundfiles
- MAX/MSPPlay PPC3.5.9 Runtime
- a copy of the score in PDF format

Equipment Needed

- 1 Power Macintosh Computer
- For best sound quality, a sound card is recommended
- 1 Microphone
- 1 Mixing Board (optional)
- 1 MIDI Interface (optional)
- 1 Foot Controller (optional)

System Requirements

- Power Macintosh G3 (233 Mhz or higher) computer
- 96 MB RAM minimum
- 200 megabytes free hard drive disk space
- MacOS 8.1 or later

Performance Setup

The soprano will need to use a microphone, that will feed into the computer via a mixer. The output from the computer goes to stereo loudspeakers, making sure that they are in front of the soprano and microphone to avoid feedback. There are two possible setups for performance: Setup #1 is with MIDI foot controller (preferred) and Setup #2 is using a mouse controller with an assistant. (for more detail see CD-ROM Read Me file)

Text Sources

The text for this composition was taken from various nursery rhymes, children's poetry, and selections from William Blake's "Songs of Innocence and Experience."

"A Cradle Song" - William Blake (1757-1827)

Sweet dreams *(form a shade,*
O'er my lovely infants head).
Sweet dreams of pleasant streams,
By happy silent moony beams
Sweet sleep with soft down.
(Weave thy brows an infant crown).
Sweet sleep *(Angel mild),*
(Hover o'er my) happy child.
Sweet smiles in the night,
(Hover over my delight.
Sweet smiles Mothers smiles
All the livelong night beguiles).
(Sweet moans, dovelike sighs),
Chase not slumber from thy eyes,
(Sweet moans. sweeter smiles,
All the dovelike moans beguiles.)
... Sleep sleep happy child, ... [30]

"Infant Joy" - William Blake (1757-1827)

I have no name,
I am but two days old.
What shall I call thee?
I happy am,

[30] the bracketed text of this poem was omitted purposefully in order to keep with the intended light hearted mood of the composition *Child Voice*.

Joy is my name.
Sweet joy befall thee!
Pretty joy!
Sweet joy but two days old,
Sweet joy I call thee;
Thou dost smile,
I sing the while -
Sweet joy befall thee.

"Spring" - William Blake (1757-1827)

... Sweet and small,
... So do you.
Merry voice
Infant noise ...

"What are little boys made of" - Robert Southey (c.1820)

... Sugar and spice
And all things nice,
That's what little girls are made of. ...

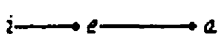
"A Cradle Song" - Thomas Dekker (1572-1632)

Golden slumbers kiss your eyes,
Smiles awake you when you rise.
Sleep, pretty (wantons),[31] do not cry,
And I will sing a lullaby:
Rock them, rock them, lullaby.

[31] "wantons" was the original text, it was replaced with the text "baby" for this composition, *Child Voice*.

Notation

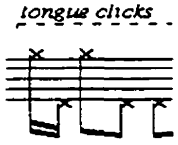
a = pure Italian vowels, in italics: *i* as in **bee**, *e* as in **day**, *a* as in **raw**, *o* as in **row**, *u* as in **moon**



= vowel modulation: gradual transformation of the oral cavity

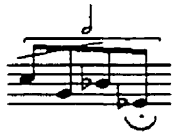
(t)ext = part of the text within the brackets is SILENT

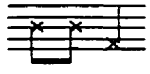
[text] = repeat the text within the brackets for ALL note heads



= HIGH tongue click with an open mouth, the oral cavity is in the shape of the vowel "a"

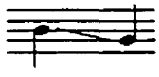
= LOW tongue click with an open mouth, the oral cavity is in the shape of the vowel "o"


= sing as fast as possible, holding the last note for the remainder of the duration marked above the bracket

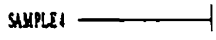

= sprechstimme: between sung and spoken voice

= intonation curve: a fluctuating glissando following the path of the line drawn between two pitches


= glissando, rising and falling between given pitches


= glissando, smooth acsending or decending between given pitches

0:00 = exact timings (0:00) = approximate timings



= indicates the duration of the soundfile

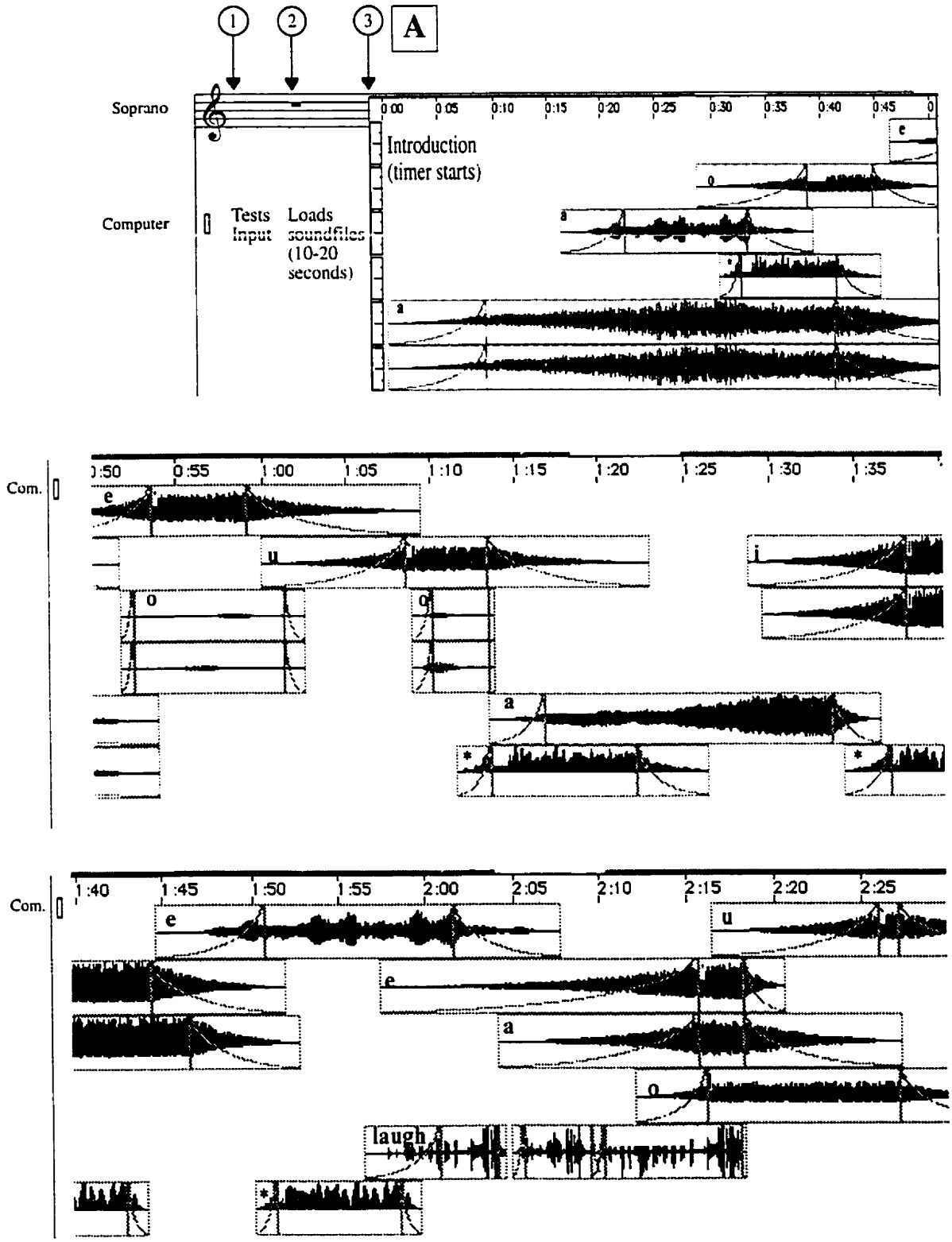
= event number of cue for program change

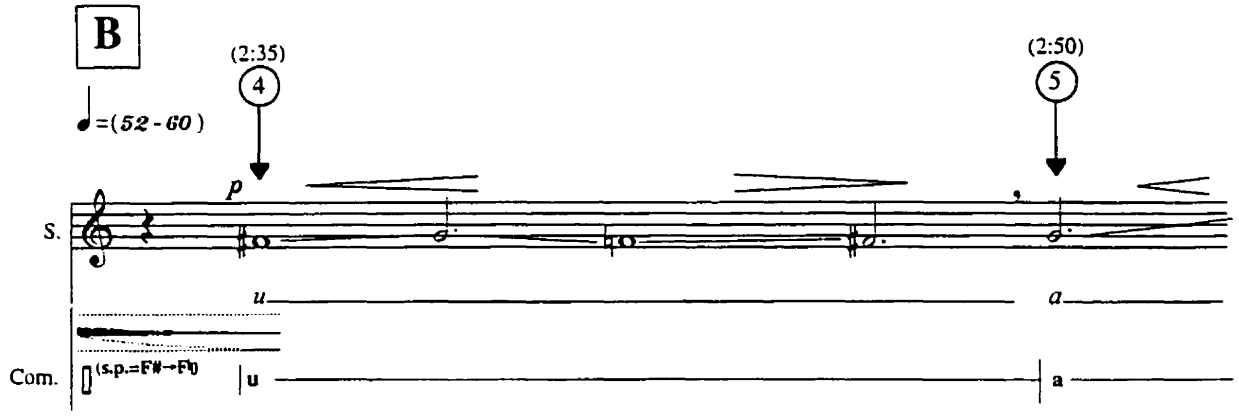
(s.p. = F) = starting pitch for soprano: pitch of the indicated soundfile

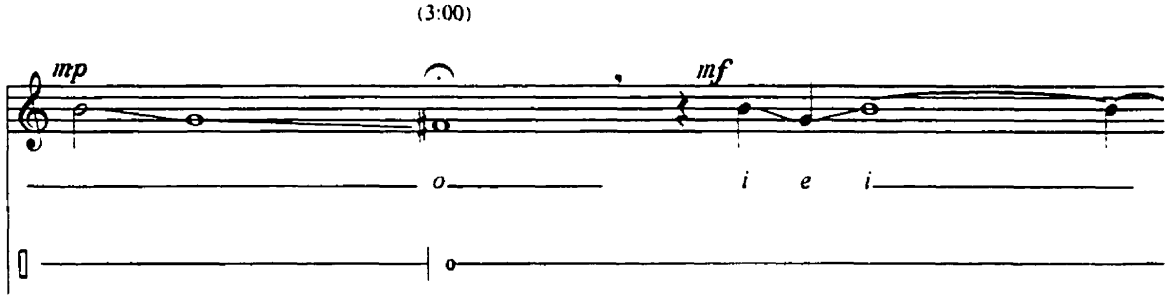
Child Voice (1999)

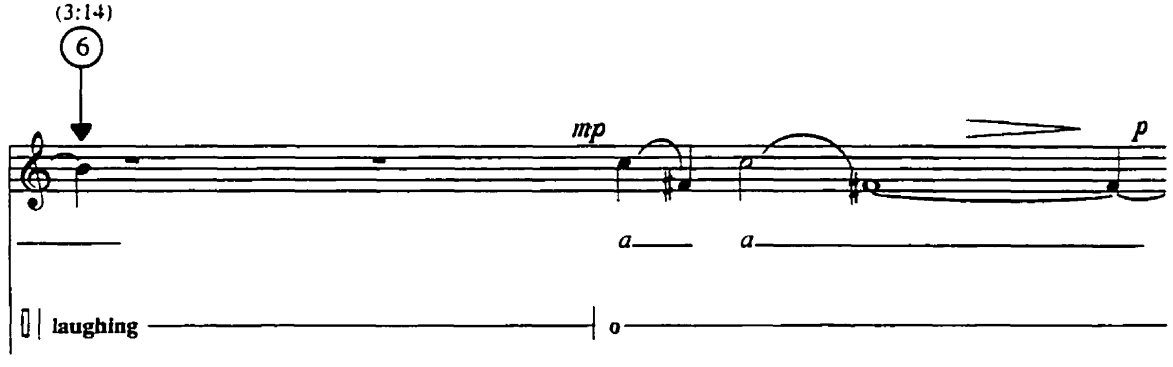
Interactive work for Soprano and Computer

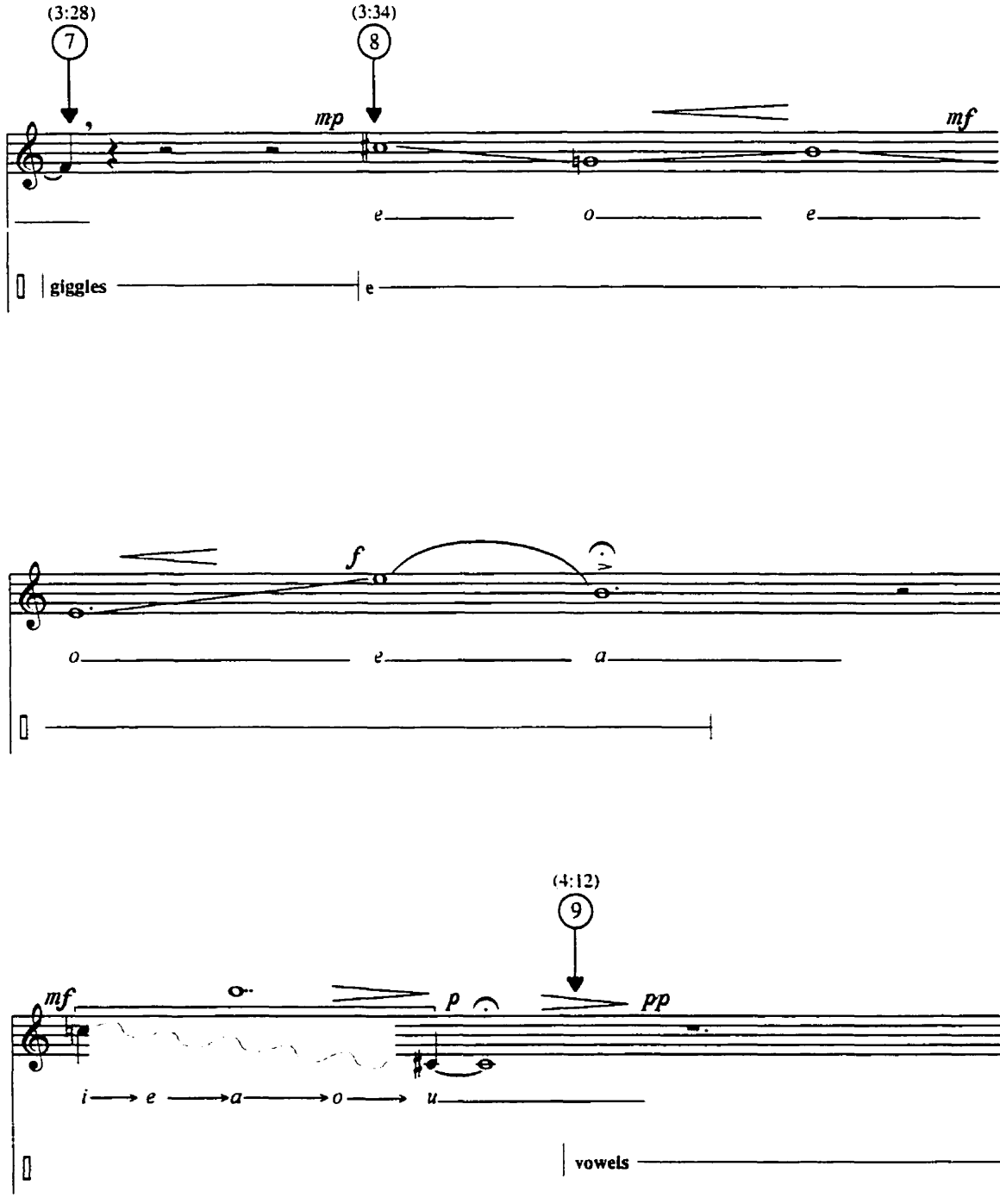
Patricia Lynn Dirks

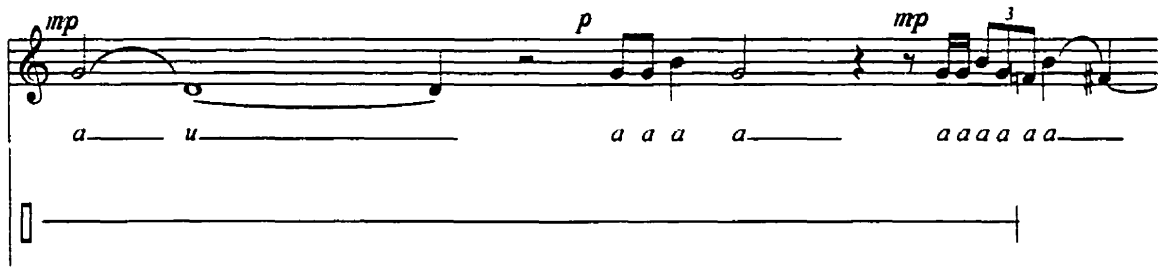


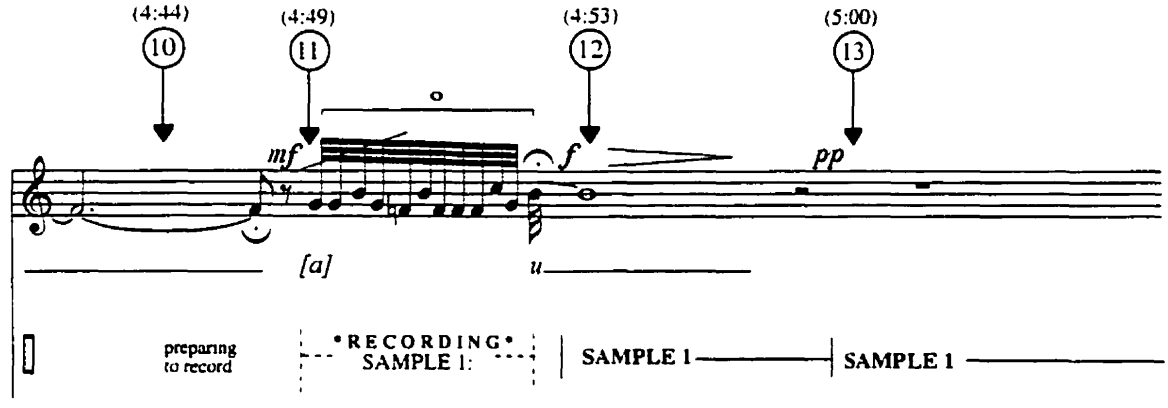

B
(2:35)
4
(2:50)
5
=(52-60)
p
S.
u
a
Com.
(s.p.=F#→F♮)
u
a

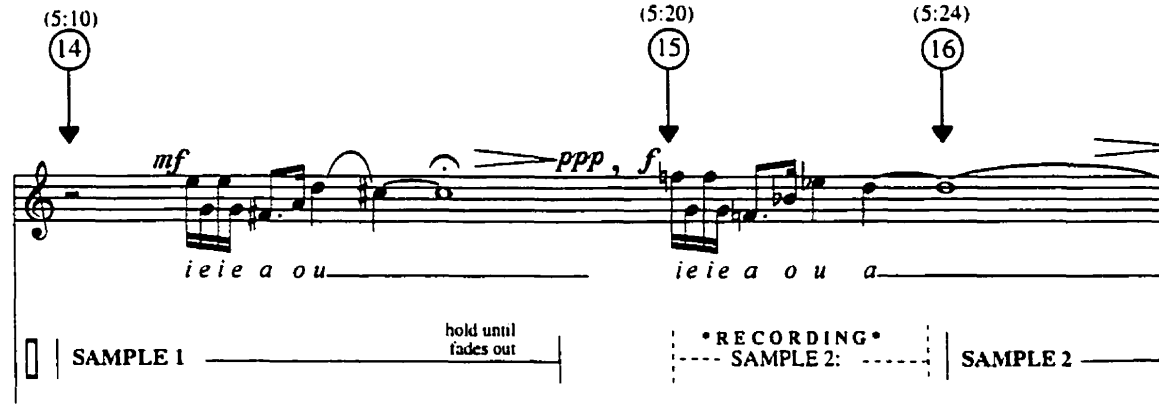

(3:00)
mp
mf
o
i e i
o

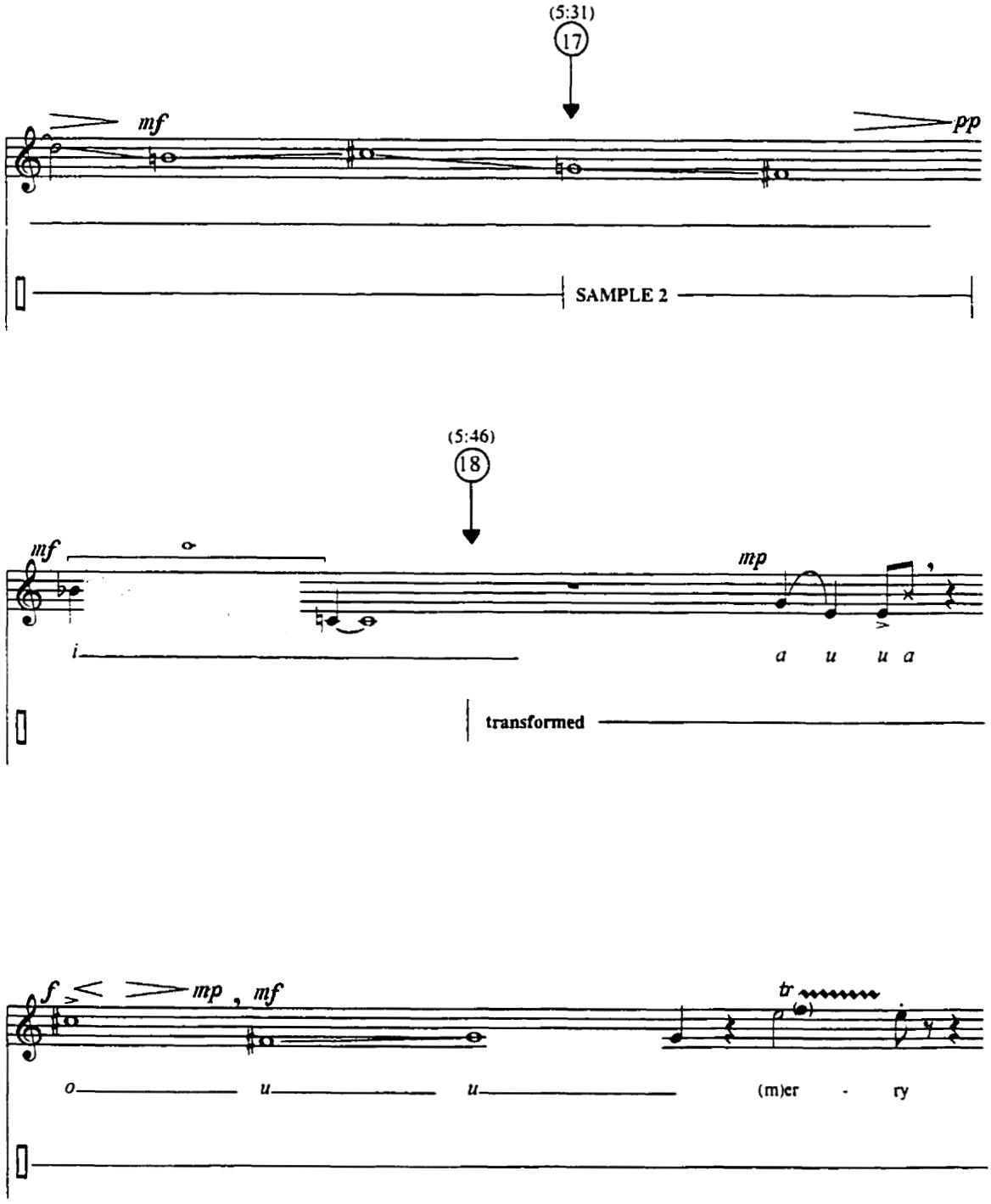

(3:14)
6
mp
p
a
a
laughing
o

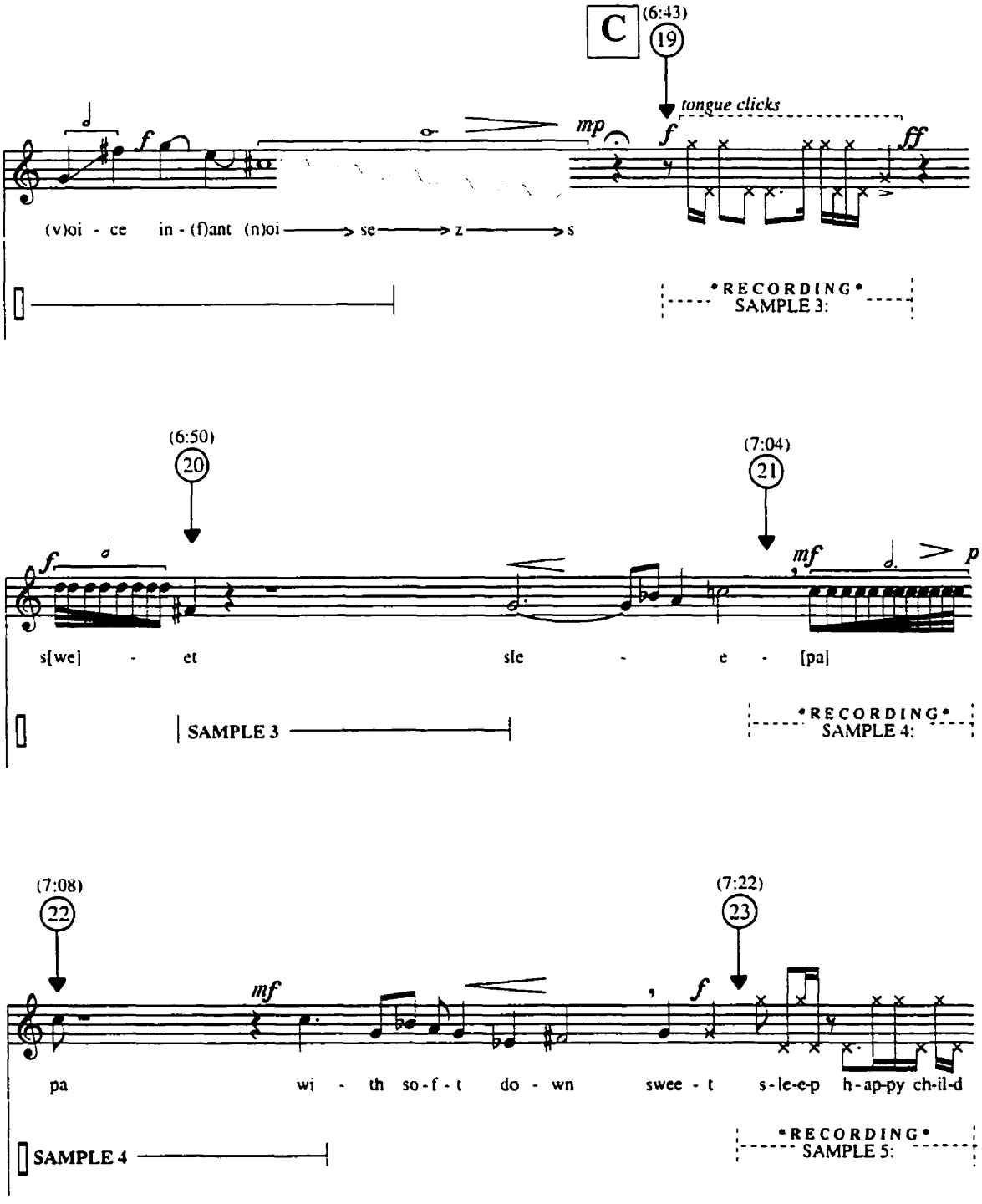

(3:28)
7
(3:34)
8
mp
mf
e
o
e
giggles
e
f
o
e
a
(4:12)
9
mf
p
pp
i
e
a
o
u
vowels

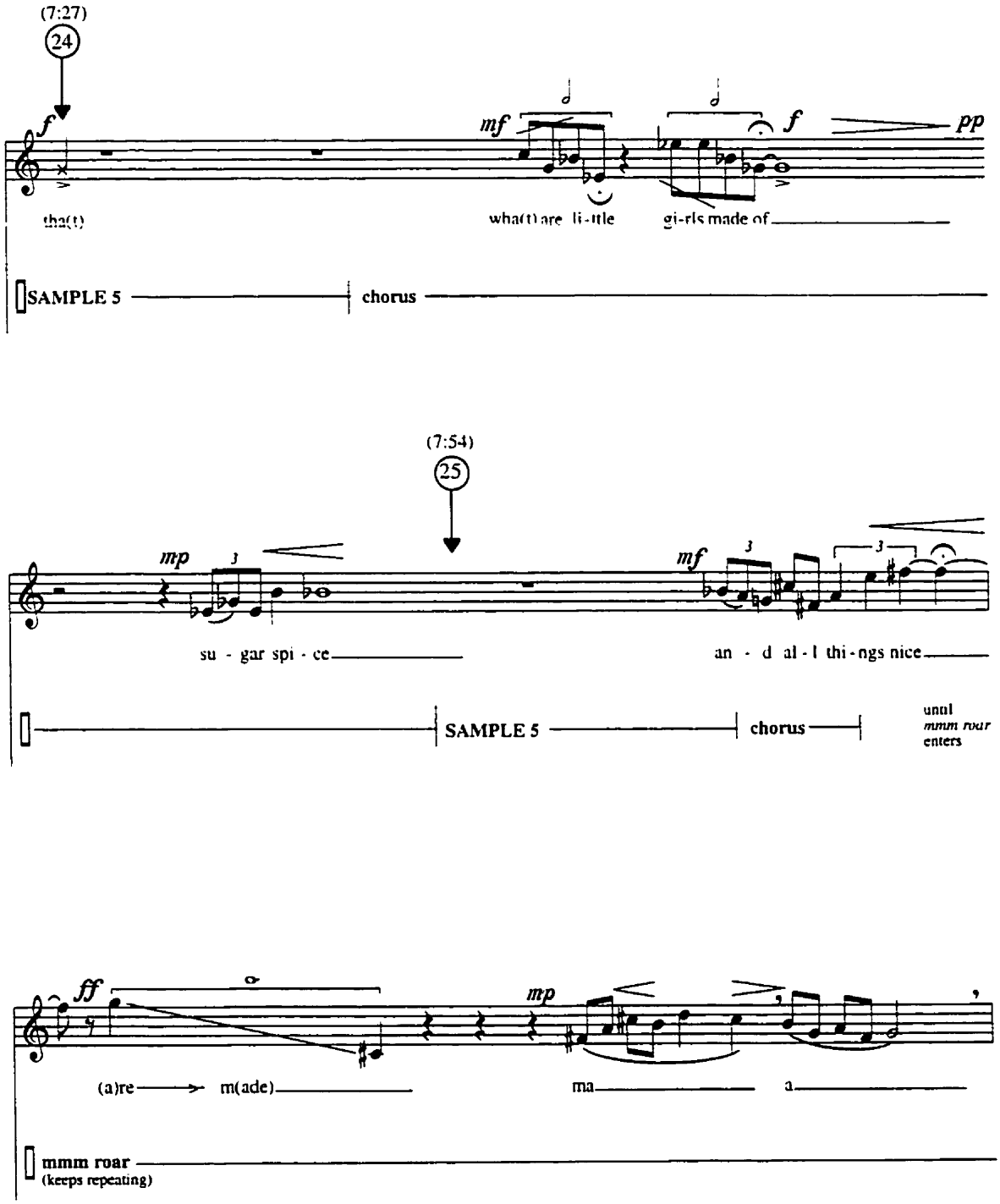

mp
p
mp
3
a u
a a a a
a a a a a a

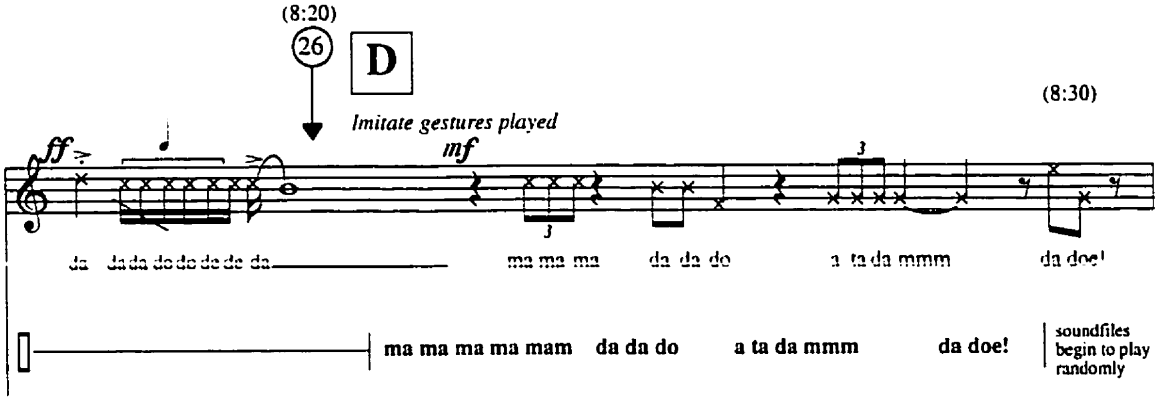

(4:44)
10
(4:49)
11
(4:53)
12
(5:00)
13
mf
f
pp
[a]
u
preparing to record
RECORDING
SAMPLE 1:
SAMPLE 1
SAMPLE 1


(5:10)
14
(5:20)
15
(5:24)
16
mf
ppp
f
i e i e a o u
i e i e a o u a
SAMPLE 1
hold until fades out
RECORDING
SAMPLE 2:
SAMPLE 2


(5:31)
17
mf
pp
SAMPLE 2
(5:46)
18
mf
mp
i
a u u a
transformed
f
mp
mf
tr
o u u
(m)er - ry

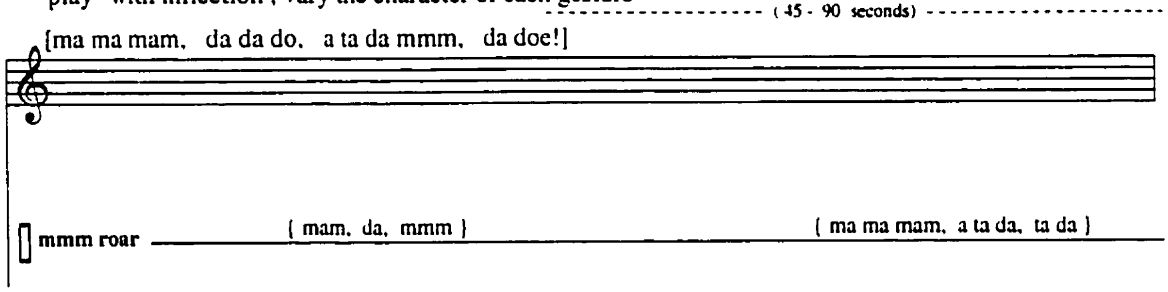

C
(6:43)
19
tongue clicks
mp
f
ff
(v)oi - ce in - (f)ant (n)oi → se → z → s
RECORDING
SAMPLE 3:
(6:50)
20
(7:04)
21
mf
p
s[we] - et sle - e - [pa]
SAMPLE 3
RECORDING
SAMPLE 4:
(7:08)
22
(7:22)
23
mf
f
pa wi - th so-f-t do - wn swee - t s-le-e-p h-ap-py ch-il-d
SAMPLE 4
RECORDING
SAMPLE 5:

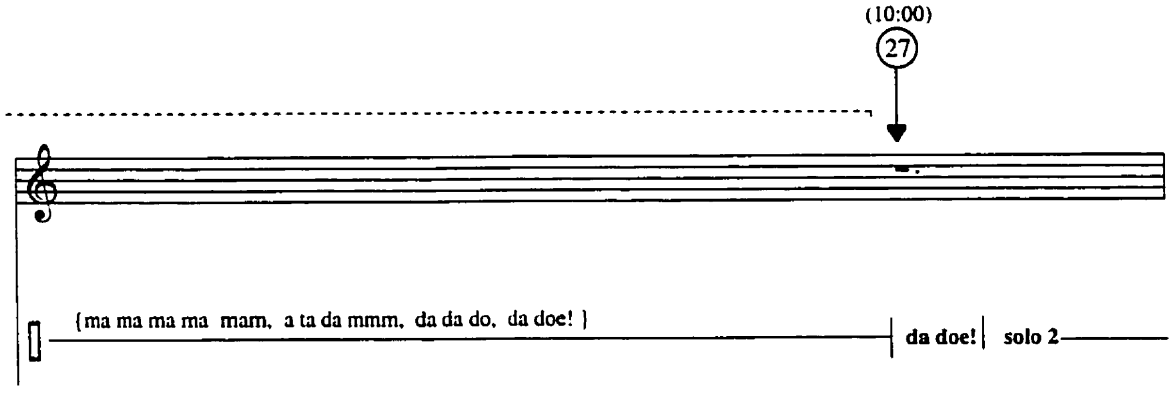

(7:27)
24
f
mf
f
pp
tha(t)
wha(t) are li-ttle
gi-rls made of
SAMPLE 5
chorus
(7:54)
25
mp
mf
su - gar spi - ce
an - d al - l thi - ngs nice
SAMPLE 5
chorus
until
mmm roar
enters
ff
mp
(a)re
m(ade)
ma
a
mmm roar
(keeps repeating)

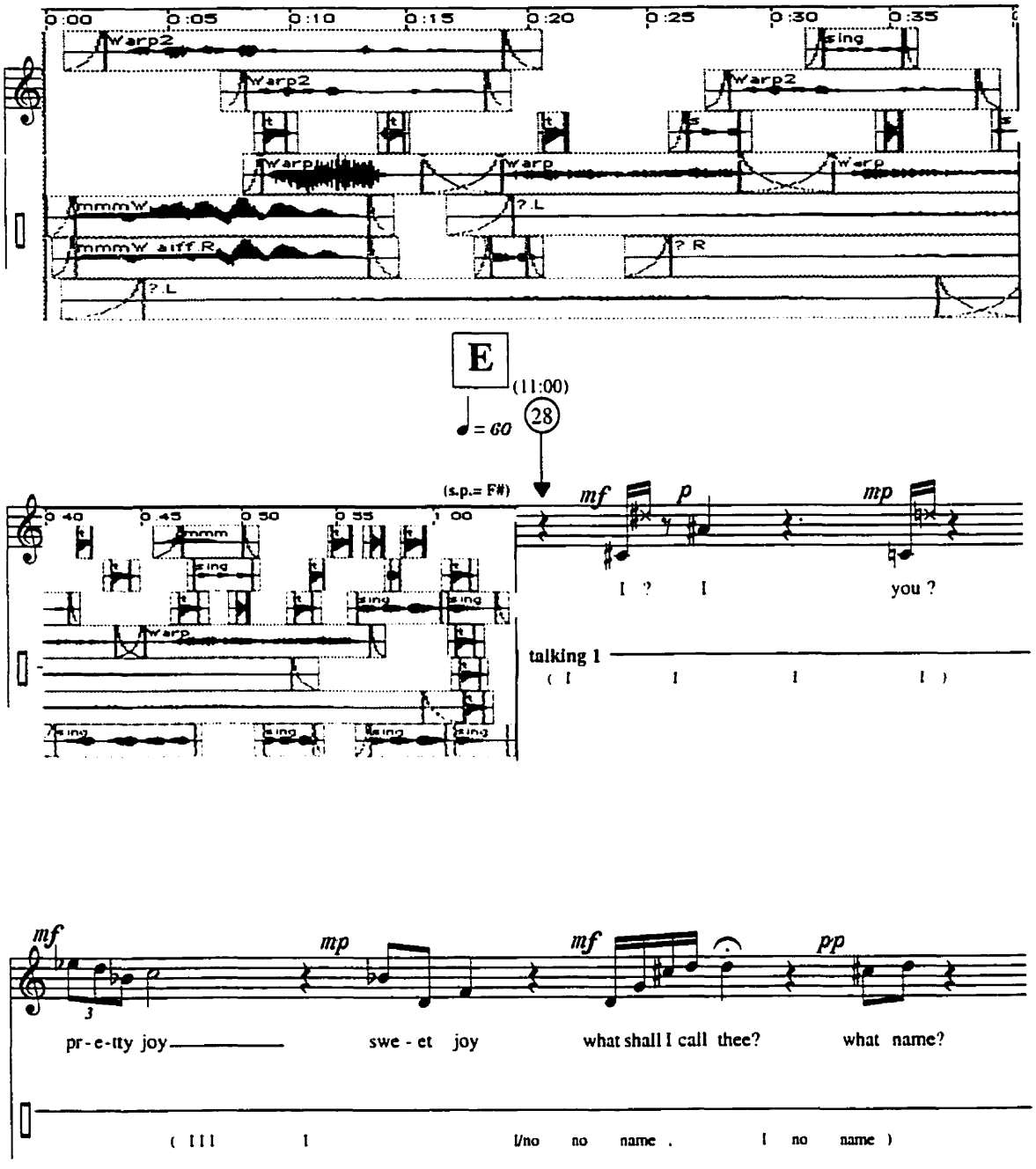


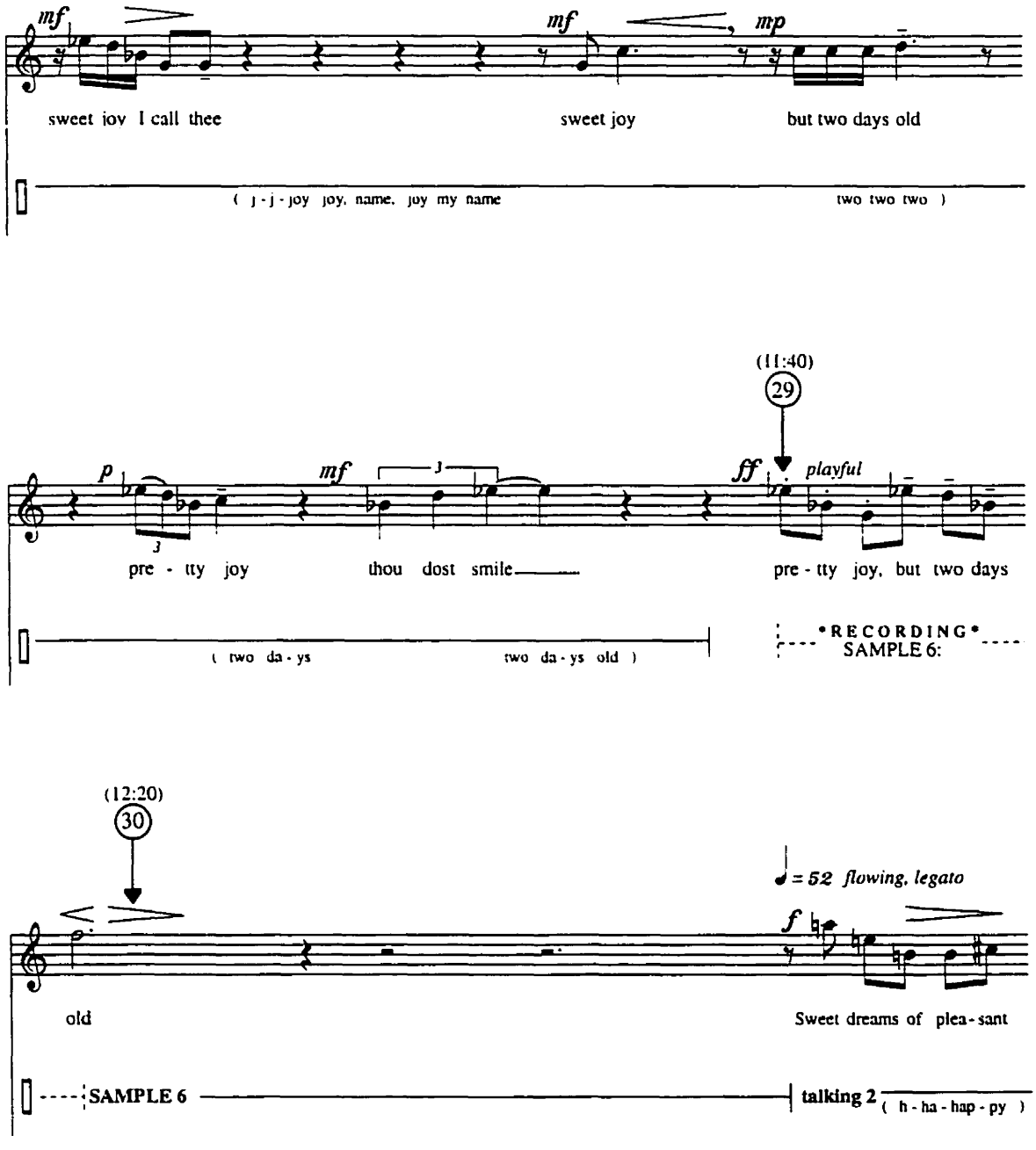
Begin to IMPROVISE on previous gestures:
"play" with inflection , vary the character of each gesture

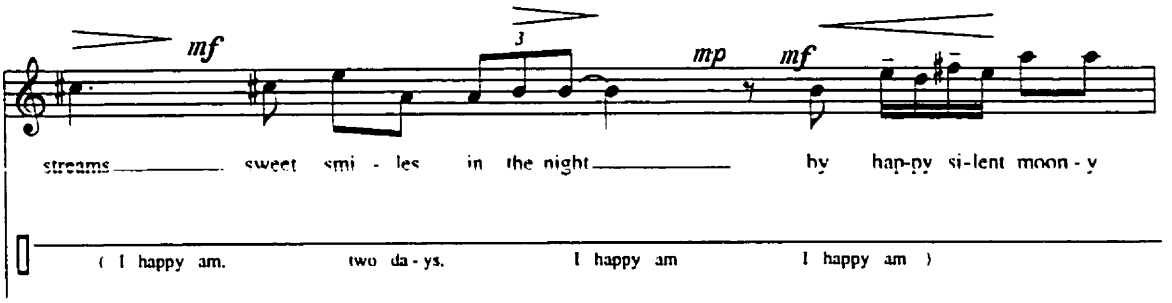
(45 - 90 seconds)

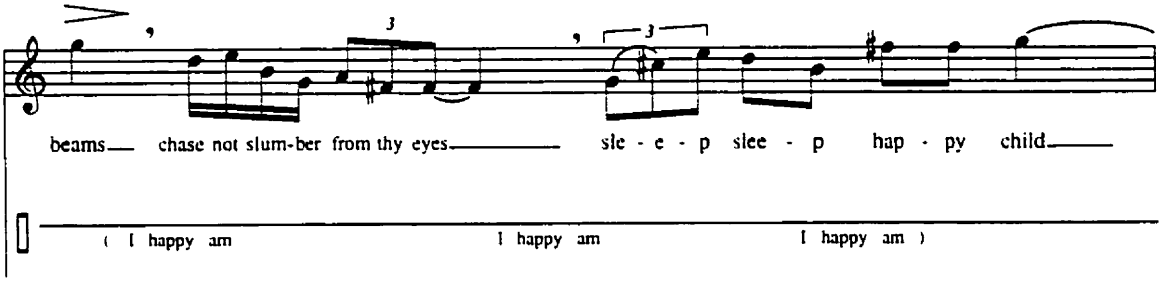


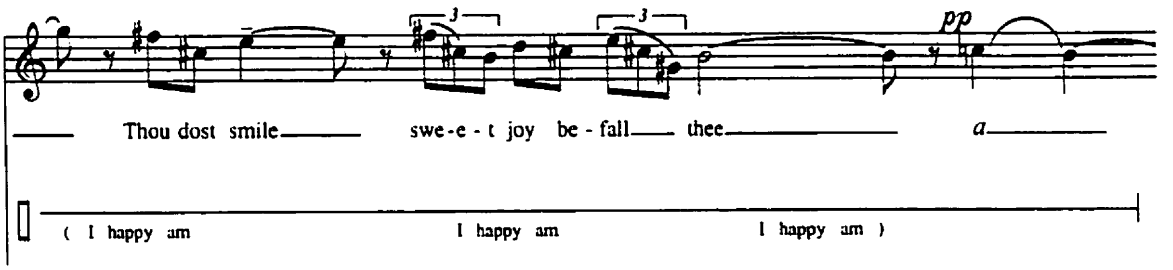


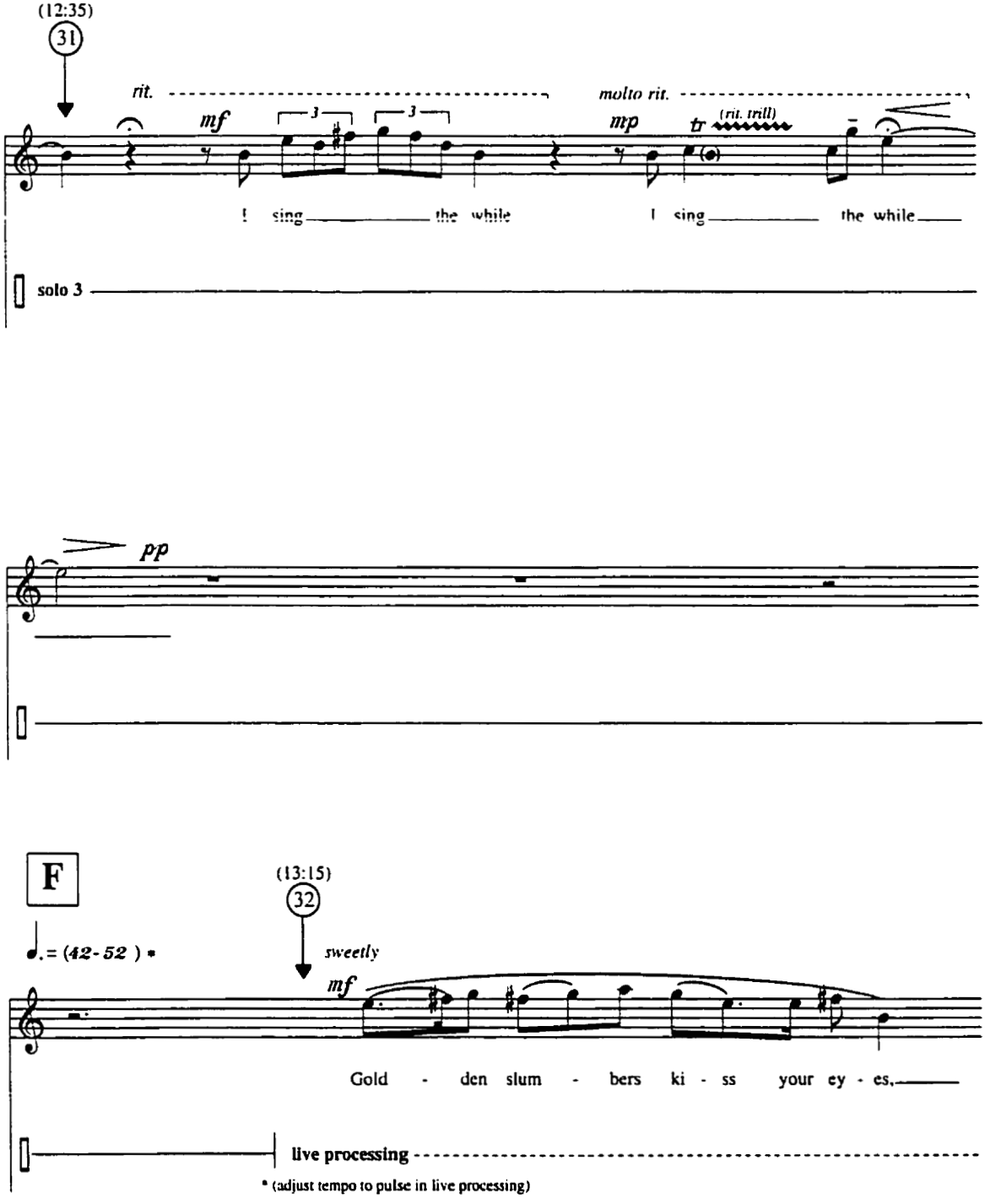

0:00
0:05
0:10
0:15
0:20
0:25
0:30
0:35
Warp2
sing
mmmW
mmmW aiff R
?.L
?.R
E
(11:00)
♩= 60
28
(s.p.= F#)
0:40
0:45
0:50
0:55
1:00
mmm
Warp
mf
p
mp
I ? I
you ?
talking 1
(I I I I)
mf
mp
mf
pp
pr-e-tty joy
swe - et joy
what shall I call thee?
what name?
(III I
I/no no name . I no name)

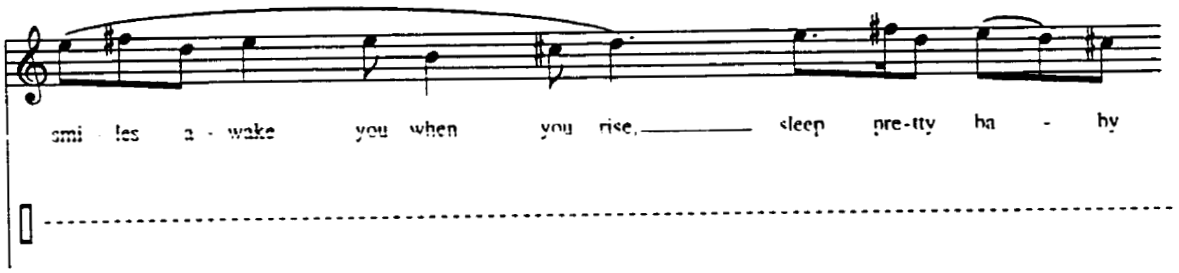

mf
mf
mp
sweet joy I call thee
sweet joy
but two days old
(j - j - joy joy, name, joy my name
two two two)
(11:40)
29
p
mf
ff
playful
pre - tty joy
thou dost smile
pre - tty joy, but two days
(two da - ys
two da - ys old)
RECORDING
SAMPLE 6:
(12:20)
30
♩ = 52 flowing, legato
f
old
Sweet dreams of plea - sant
SAMPLE 6
talking 2
(h - ha - hap - py)

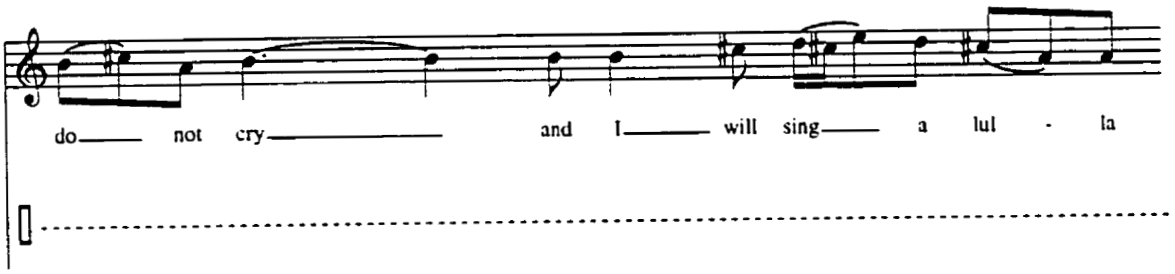

mf
mp
mf
streams sweet smi - les in the night by hap-py si-lent moon - y
(I happy am. two da - ys. I happy am I happy am)

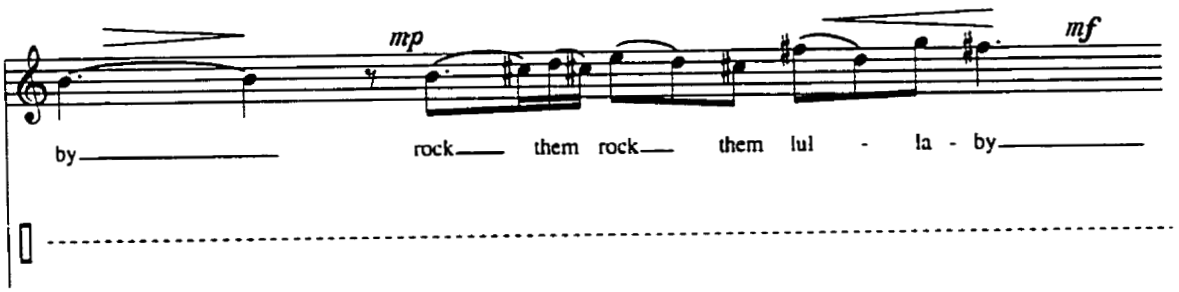

beams chase not slum-ber from thy eyes sle - e - p slee - p hap - py child
(I happy am I happy am I happy am)

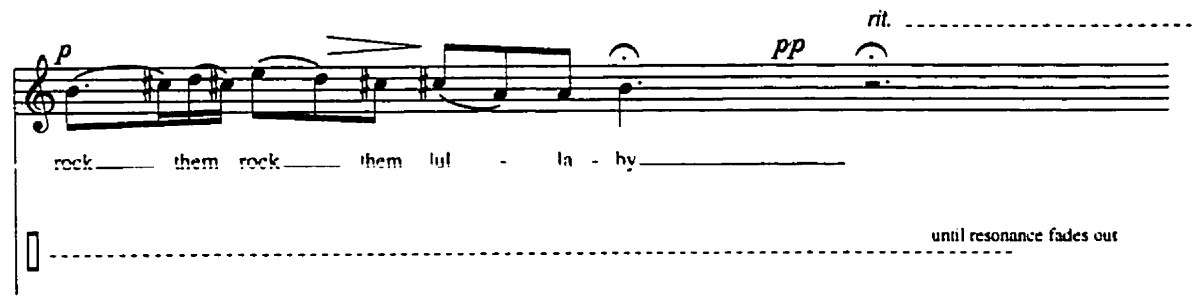

pp
Thou dost smile swe-e - t joy be - fall thee a
(I happy am I happy am I happy am)

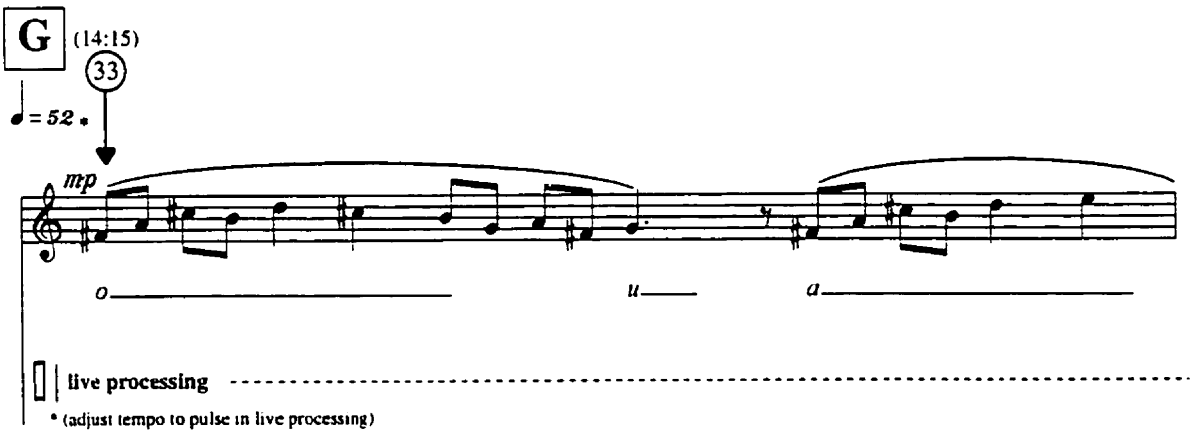

(12:35)
31
rit.
mf
molto rit.
mp
tr
(rit. trill)
I sing the while
I sing the while
solo 3
pp
F
(13:15)
32
♩. = (42-52) *
sweetly
mf
Gold - den slum - bers ki - ss your ey - es,
live processing
* (adjust tempo to pulse in live processing)

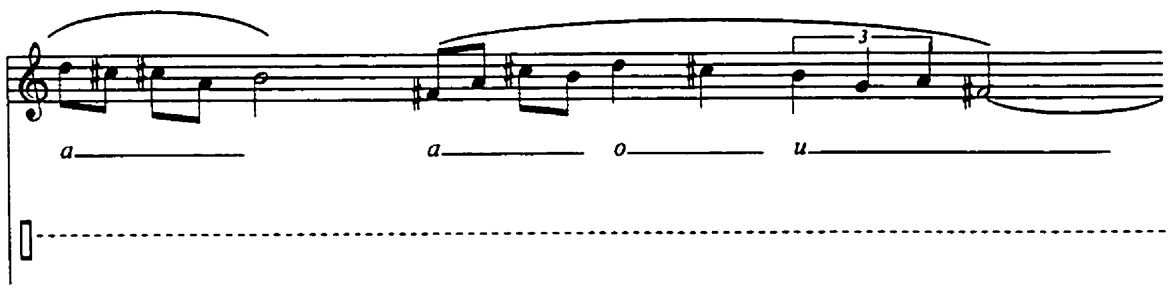

smi les a - wake you when you rise, sleep pre-tty ba - by

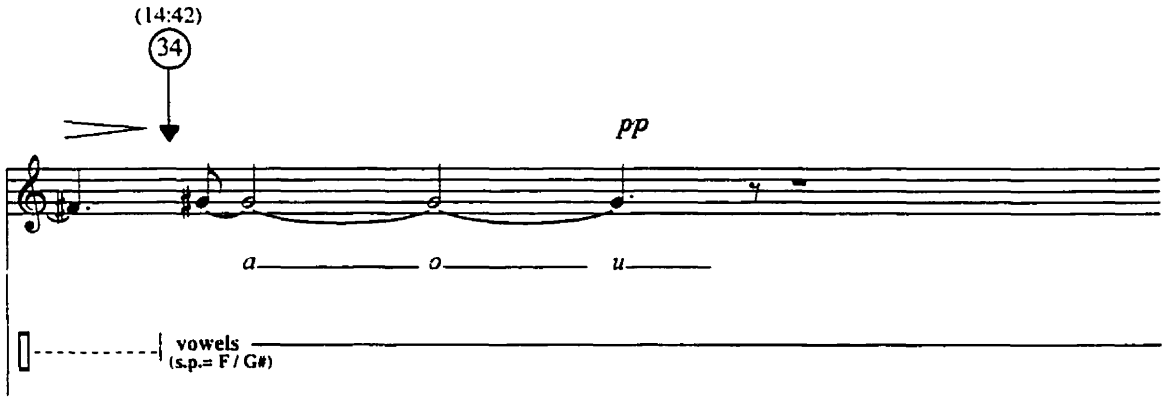

do not cry and I will sing a lul - la

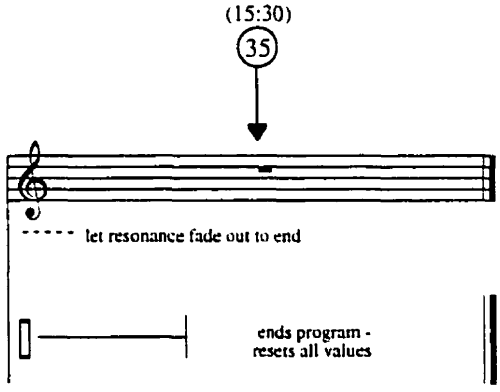

mp
mf
by rock them rock them lul - la - by


rit.
p
pp
rock them rock them lul - la - by
until resonance fades out


G
(14:15)
33
♩ = 52 *
mp
o u a
live processing
* (adjust tempo to pulse in live processing)


3
a a o u


(14:42)
34
pp
a
o
u
vowels
(s.p.= F / G#)


(15:30)
35
let resonance fade out to end
ends program -
resets all values

BIBLIOGRAPHY

AnnaLies v 4.3.1. David Hirst, La Trobe University, Australia, 1996.

Backus, John. The Acoustical Foundations of Music. 2d ed. New York: W.W. Norton and Company, 1977.

Berio, Luciano. "Thema: Omaggio a Joyce." On Electronic music III. Turnabout. TV 34177, 1969.

Berio, Luciano. Sinfonia. London: Universal Edition Ltd., 1972.

Blake, William. Songs of Innocence and Experience. Edited by Andrew Lincoln. Princeton: William Blake Trust/Princeton University Press, 1991.

Blyton, Carey, ed. Golden Slumbers. In The Faber Book of Nursery Songs. London: Faber and Faber Limited, 1968.

Cecilia 2.0.2 for MacOS. Alexandre Burton and Jean Piché, Université de Montréal, Quebec, 1995-98.

Dekker, Thomas. A Cradle Song. In The Oxford Book of Children's Verse, eds. Iona and Peter Opie. Oxford: Oxford University Press, 1973.

Dodge, Charles. The Waves. Text by Virginia Woolf. New York: American Composers Alliance, 1984.

Harvey, Jonathan. "Mortuos Plango, Vivos Voco." On Computer Music Currents 5. Wergo. WER 2025-2, 1990.

MAX 1.0.6-6. Opcode Systems/IRCAM, Paris, France, 1990-98.

MSP. Cycling '74, San Francisco, California, 1997-99.

Normandeau, Robert. Tangram. empreintes DIGITALes. IMED 9419/20-CD, 1994.

Pro Tools Software 3.4-4.2. Digidesign Inc., Palo Alto, California, 1997.

Stockhausen, Karlheinz. "Gesang der Jünglinge." On Gesang der Jünglinge, no.1 Kontakte. Deutsche Grammophon Gesellschaft. SLPM 138811, 1968.

Sound Effects version 0.9.2. Alberto Ricci, Torino, Italy, 1993-94.

Southey, Robert. What are little boys made of?. In The Oxford Dictionary of Nursery Rhymes, eds. Iona and Peter Opie. 3rd ed. Oxford: Clarendon Press, 1951.

Westerkamp, Hildegard. "Moments of Laughter." Score. 1988. Canadian Music Centre, Mackimmie Library, University of Calgary, Alberta.

Appendix A: Formal Shape

A	B	C	D	E	F	G
Introduction	vowels	consonants	imitation	dialogue	lullaby	conclusion
tacet	soprano entrance using changing vowel sounds, through varying glissandi, short phrases recorded	text emphasis on consonant sounds, short rhythmic phrases, tongue clicks recorded, interruptions of short fragments of a main melody	improvise on gestures played **tacet**	melodic ideas developed, longer lyrical phrases, responds to child's ideas, uses motive from SOLO in **D**, text complete phrases from "Infant Joy"	sung lullaby text from "Golden Slumbers"	theme first presented in snippets at **C**, now developed and answered using vowel sounds

Soprano

0:00 **2:30** (5:00) **6:43** **8:30** **11:00** **13:00** **14:00** (15:00)

Computer

SOLO presents manipulated vowel sounds in an electroacoustic environment, with interjections of a processed sound later revealed to be a child's laughter

various elongated vowel sounds, interjections of live digital signal processing of child's laughter, short phrases from soprano played back with live processing such as pitch changes and effects

* transition into **C**

transformed child sounds that emphasize the melodic and rhythmic nature of the sounds, as opposed to clear comprehension of the sound material

tongue clicks played back with live digital signal processing sets up polyrhythm with sung material,

climax (8:00)
-formal realization
-complete words stated

random playing of gestures, from short to longer to full phrases

phrases:
"ma ma"
"da da do"
"a ta da mmm"
"da doe!"

SOLO combines previous gestures transformed and develops a small motive repeated in section E, in soprano

talking in complete ideas, ie:
"I happy am"

live digital processing of soprano's input, forms a pulse which sets up the soprano tempo for the remainder of the section

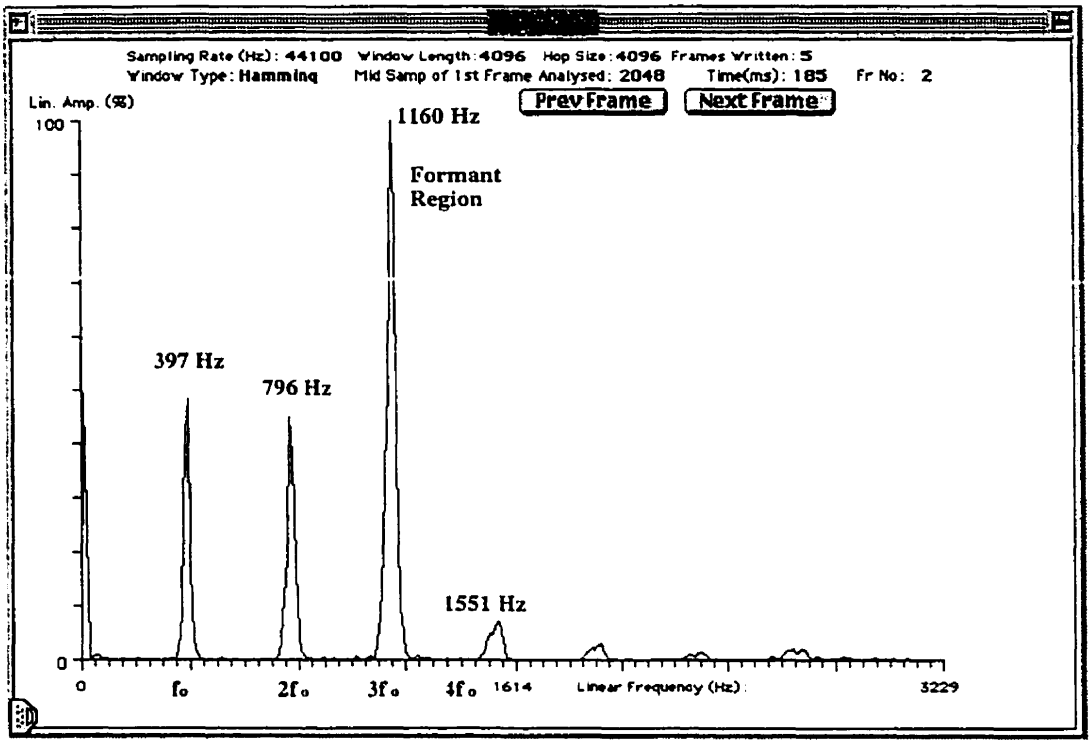
live digital processing of soprano's input

vowel sound extended return and fade out into child's laughter

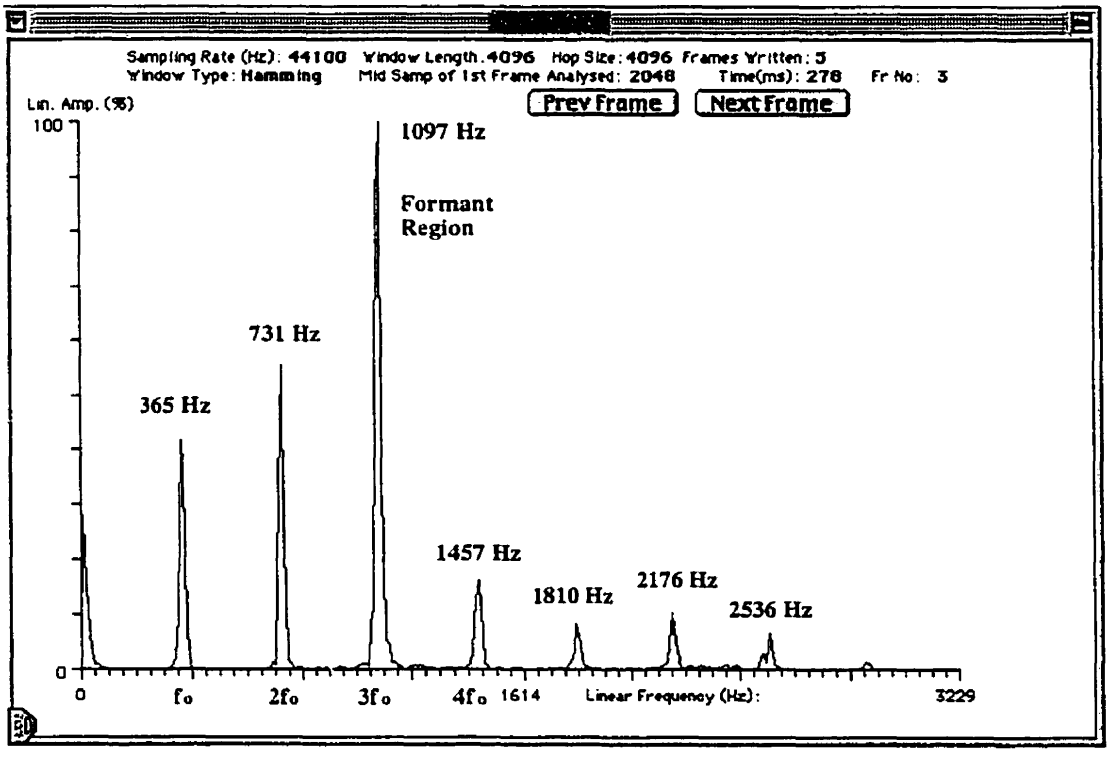
* Section D is a microcosm of the entire compostion

(Letters represent rehearsal letters)

APPENDIX B: Analysis Graphics

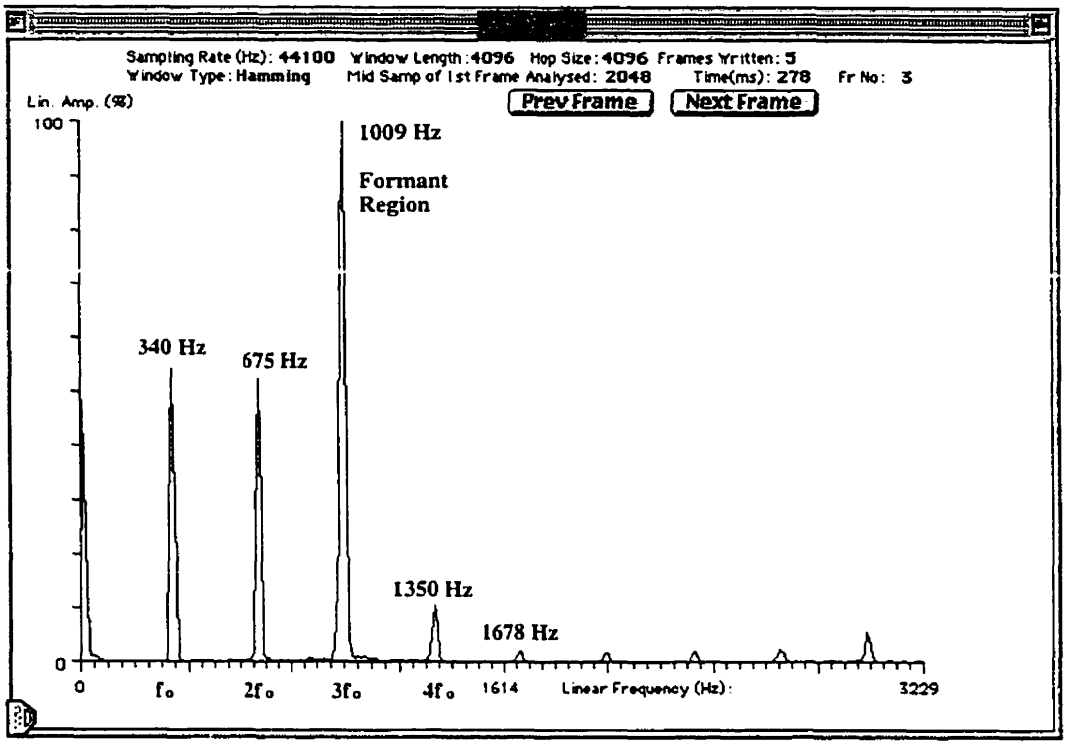


EXAMPLE 1: "e" as in "day"

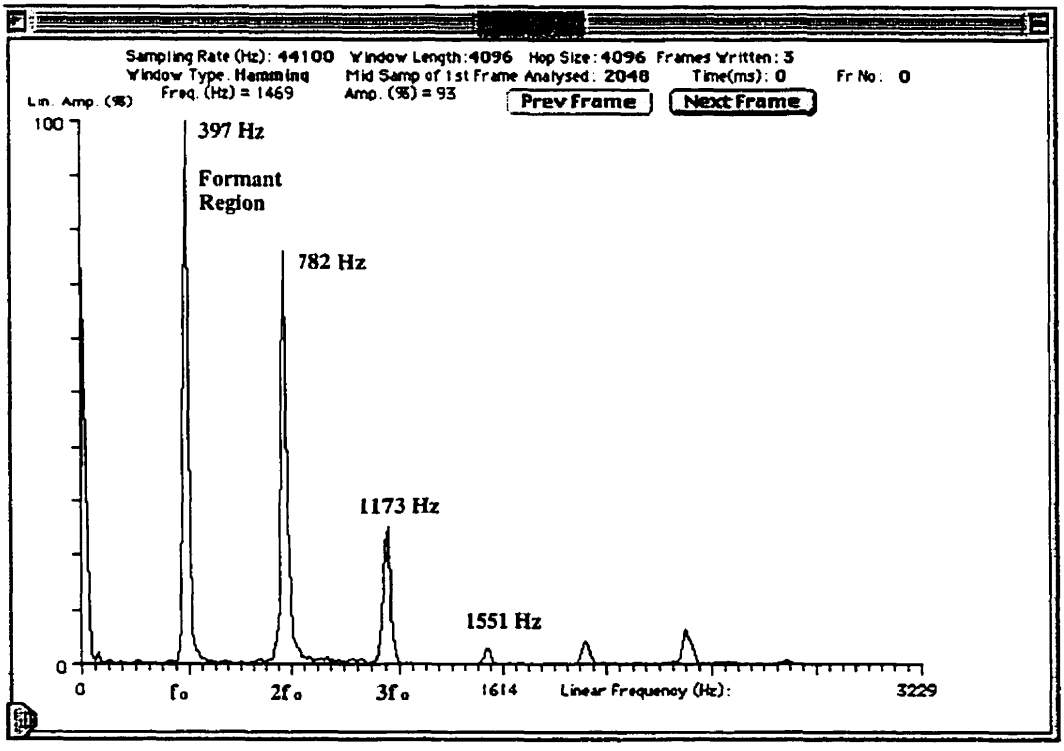


EXAMPLE 2: "a" as in "raw"

APPENDIX B: Analysis Graphics

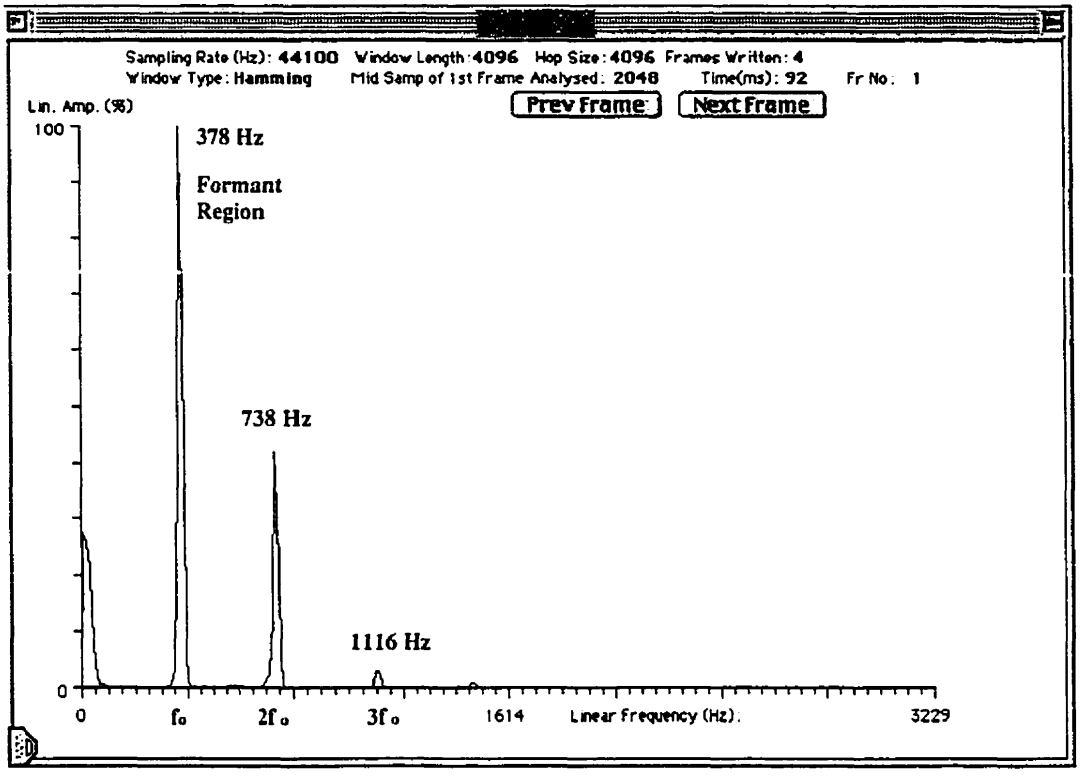


EXAMPLE 3: "i" as in "bee"



EXAMPLE 4: "o" as in "row"

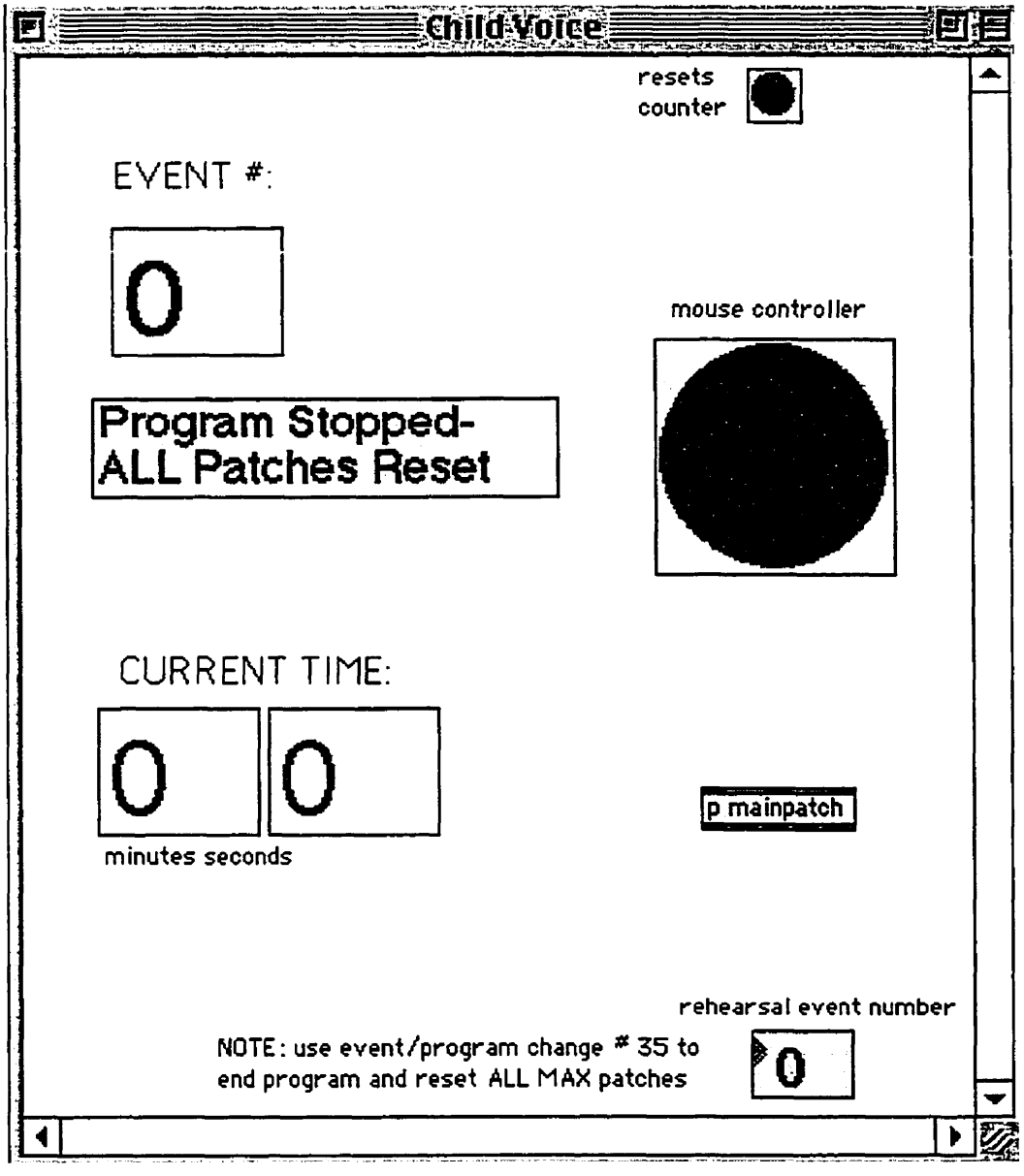
APPENDIX B: Analysis Graphics



EXAMPLE 5: "u" as in "moon"

NOTE: For comparative analysis, all samples were analyzed at a window length and hop size of 4096 samples, with a Hamming window type, a start sample of 0 Hz and end sample at 44100 Hz. This was done using the program AnnaLies version 4.3.1, created by Chris Scallan and Thomas Stainsby. This software performs a Short Time Fourier Transform (STFT) analysis of the samples and stores the information in a Fast Fourier Transform (FFT) file, which can then be displayed in two dimensional or three dimensional format. In all examples the amplitude scale has been set to a linear percentage. All graphics were plotted from channel number 0 to 300 with the Threshold of Partial Significance for peak detection expressed as 2% of the maximum amplitude for the frame. Most of the samples were plotted from frame number 0 to 5 with the exception of sample "O" plotted from frame number 0 to 3 and sample "U" plotted from frame number 0 to 4 due to the length of the original sound files.

APPENDIX C: MAX Patches



Colour Codes:

: any digital and/or audio signal converters

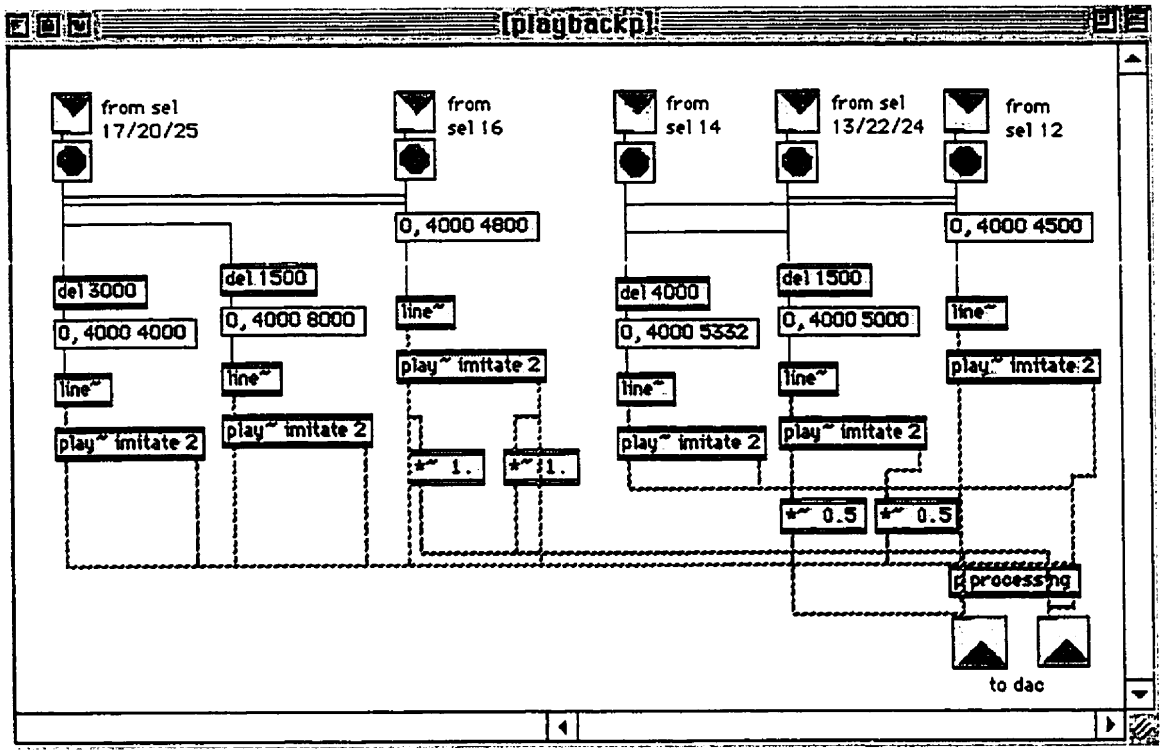
Green: all created sub patches

Pink: objects that record and /or play sound, either from stored buffer or soundfile

Blue: all buttons, except for the main mouse controller which is Pink

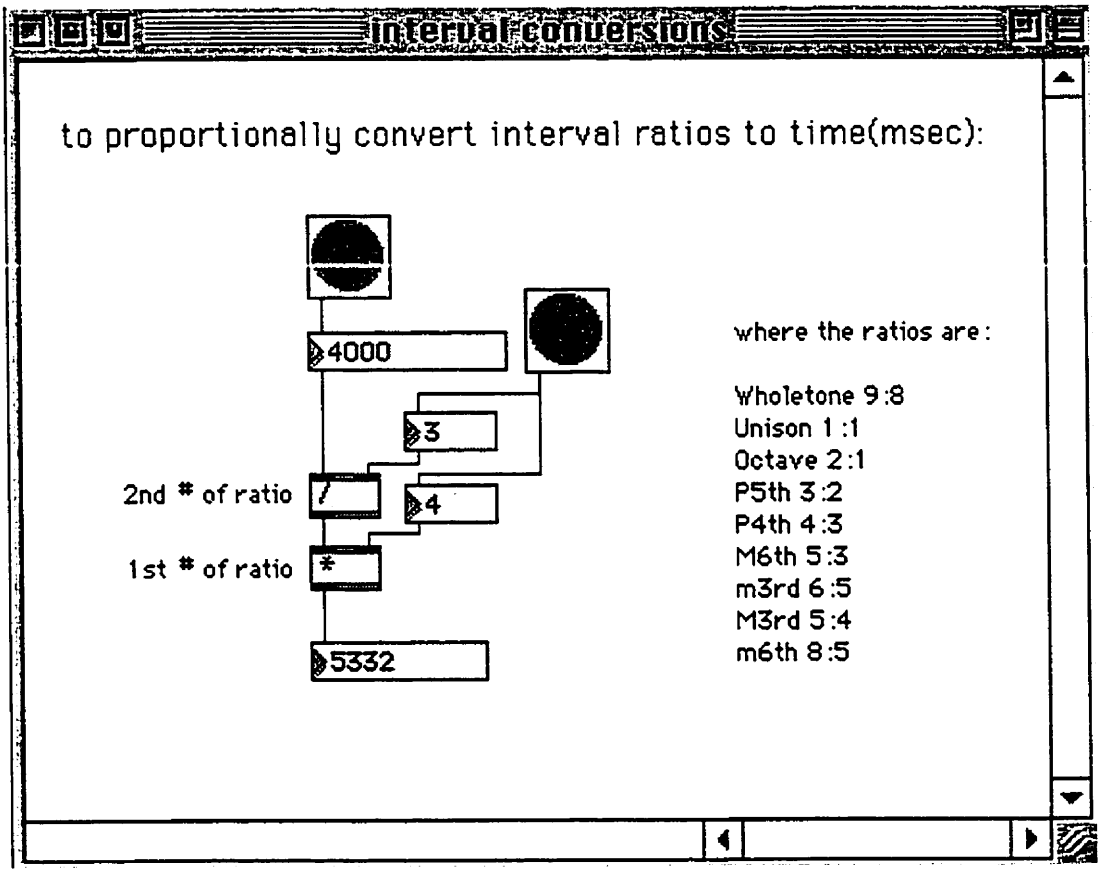
Beige: indicates the recording buffer

APPENDIX C: MAX Patches



The MAX patch "playbackp" deals with live digital signal processing during the playback of what is currently in the record buffer. Selecting event #12 sends the command (0, 4000 4500) which informs the **play~** object to play that which is in the buffer "imitate 2," starting at the beginning of the sample (0 ms) and going to the end (4000 ms) a whole tone lower (4500 ms) than the original pitch of the sample (see Appendix C: "interval conversions"). The signal now with it's original pitch altered, is then sent through the "processing" MAX patch before going out to the digital audio converter (**dac~**), located in the "mainpatch" of *Child Voice*. Selecting event #13 (22 or 24) sends a command to three separate branches thus performing the same operation as event #12, this time with delays of 1500 ms and 4000 ms at the pitch changes of a major 3rd (0, 4000 5000) and a perfect 4th (0, 4000 5332) respectively. The delayed signal at 1500 ms is amplified and does not pass through the "processing" patch but goes directly to the **dac~**. Selecting event #14 performs the initial playback (as in selecting event #12) and only one delay at 4000 ms. Similar results occur with the selection of event #'s 16, 17, 20, 22, 24 and 25, with the pitch changing a minor 3rd at 4800 ms and an octave lower at 8000 ms.

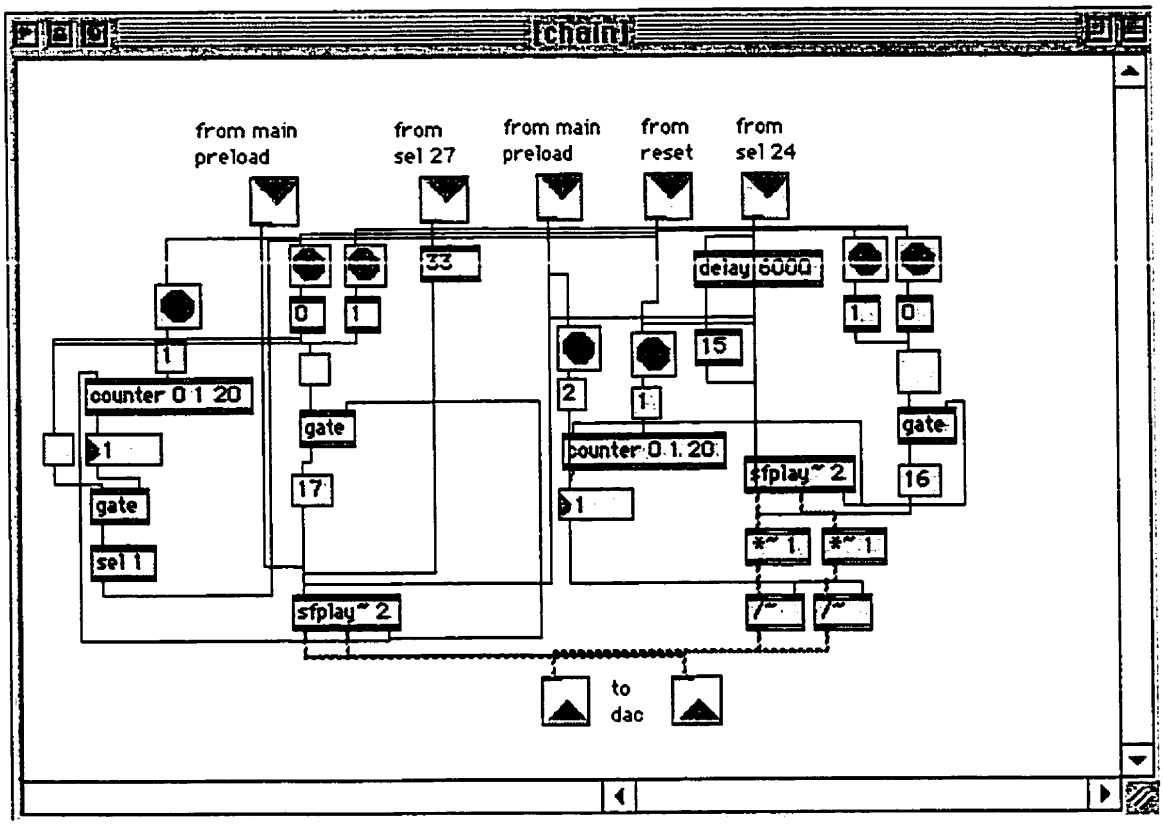
Appendix C: MAX Patches



The first input number is a unit of time in milliseconds, representing the length of a soundfile (for this example it would be 4000 ms). The remaining 2 input numbers are that of the interval ratios. To represent a perfect fourth the ratio 4:3 would be used.[32] For example the second number of the ratio (3) becomes the second input number and thus the first number (4) becomes the third input number. The activating of the buttons will produce the resultant number 5332 ms. When the resulting number is larger then the original the pitch of the sample will be lower. The reverse is true when the numbers in the ratio are input in the order they appear (thus producing a smaller number than the original), resulting in a higher pitched sample.

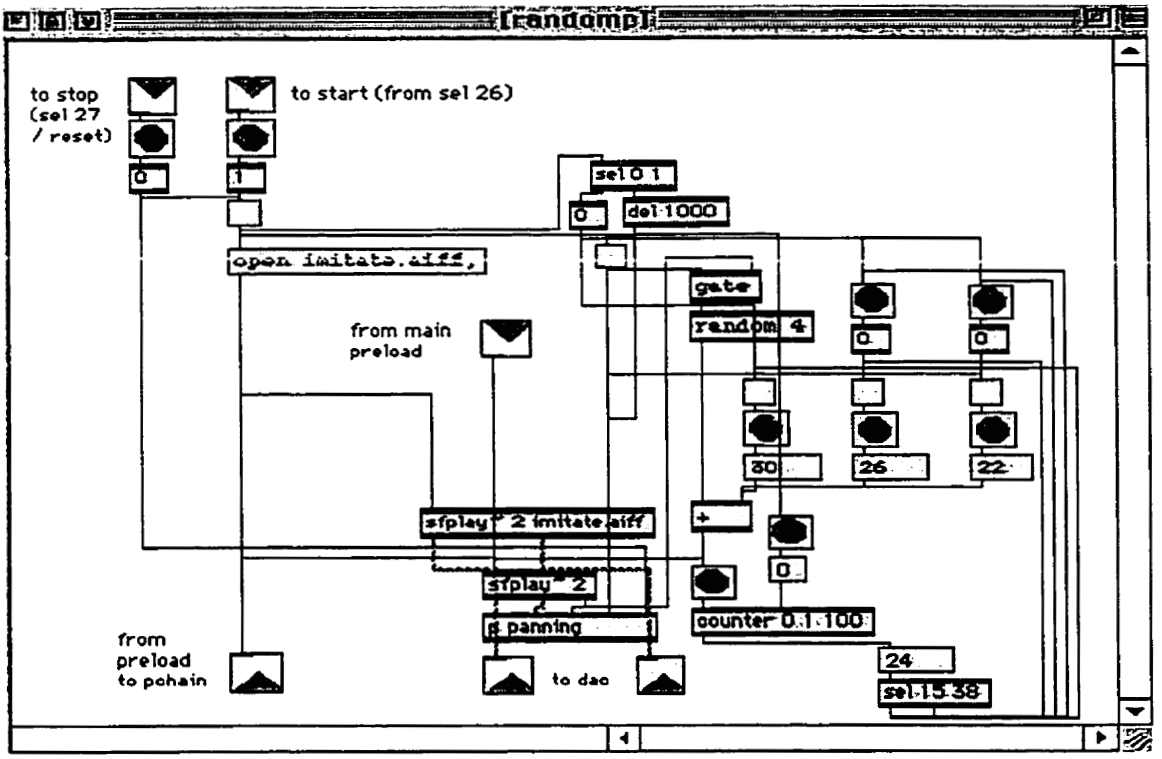
[32] Backus, 136.

APPENDIX C: MAX Patches



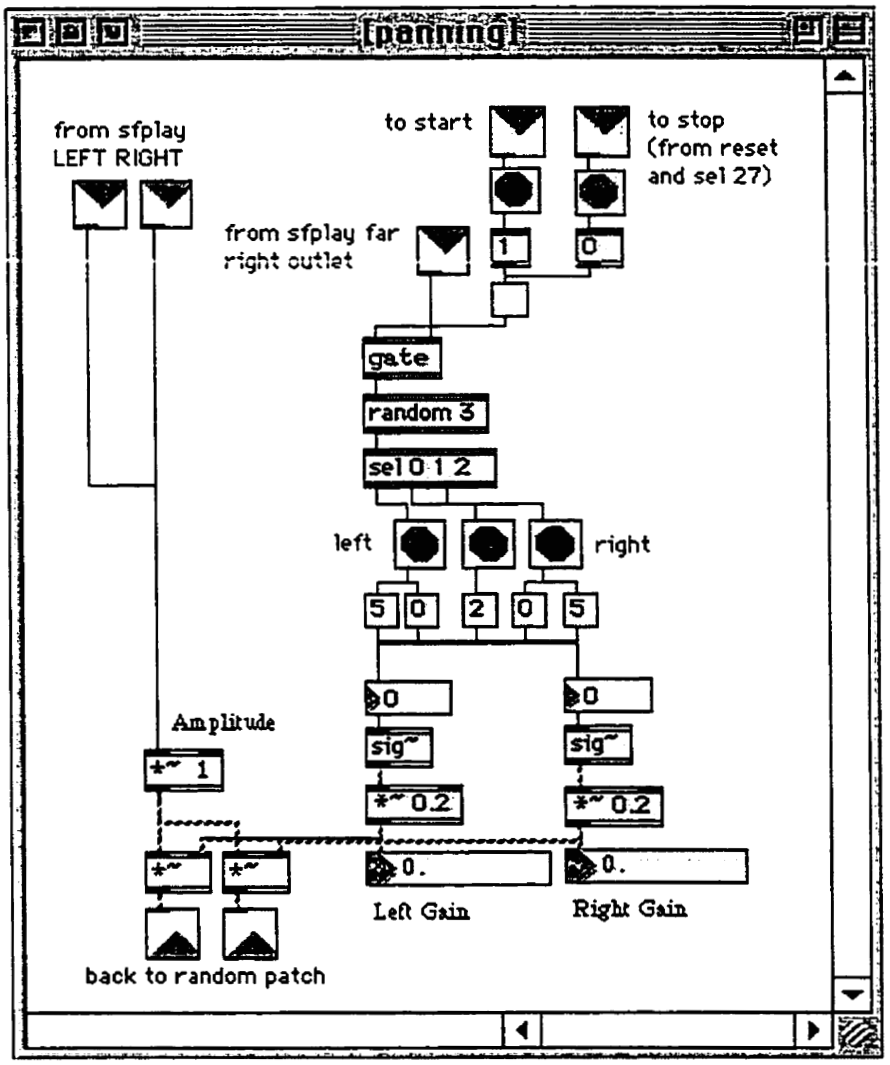
In the MAX patch "chain" selecting event #24 opens the right gate of the patch and sends a signal delaying the playback of soundfile 15 (chorus) by 6000 ms. When the soundfile (chorus) is finished, the **sfplay~** object outputs a bang which a) starts the counter to begin counting from numbers 2 to 20 and b) sends a signal through the open gate to trigger the playing of soundfile 16 (mmm roar). The playback volume of this soundfile (mmm roar) is controlled via the counter, which is sending the current count of soundfiles played to the division object. Therefore, the current volume level of the soundfile (mmm roar) will gradually decrease with every repeat until event #27 is triggered. This will a) close the open gate thus stopping any further playing of the soundfile (mmm roar), b) trigger the playing of soundfile 33 (da doe!), and c) open the left most gate. When this short soundfile is completed, the **sfplay~** object then sends a bang to the left counter. Once the counter has reached the count of 1 the middle gate is opened, thus playing soundfile 17 (Tape Solo #2) occurs.

APPENDIX C: MAX Patches



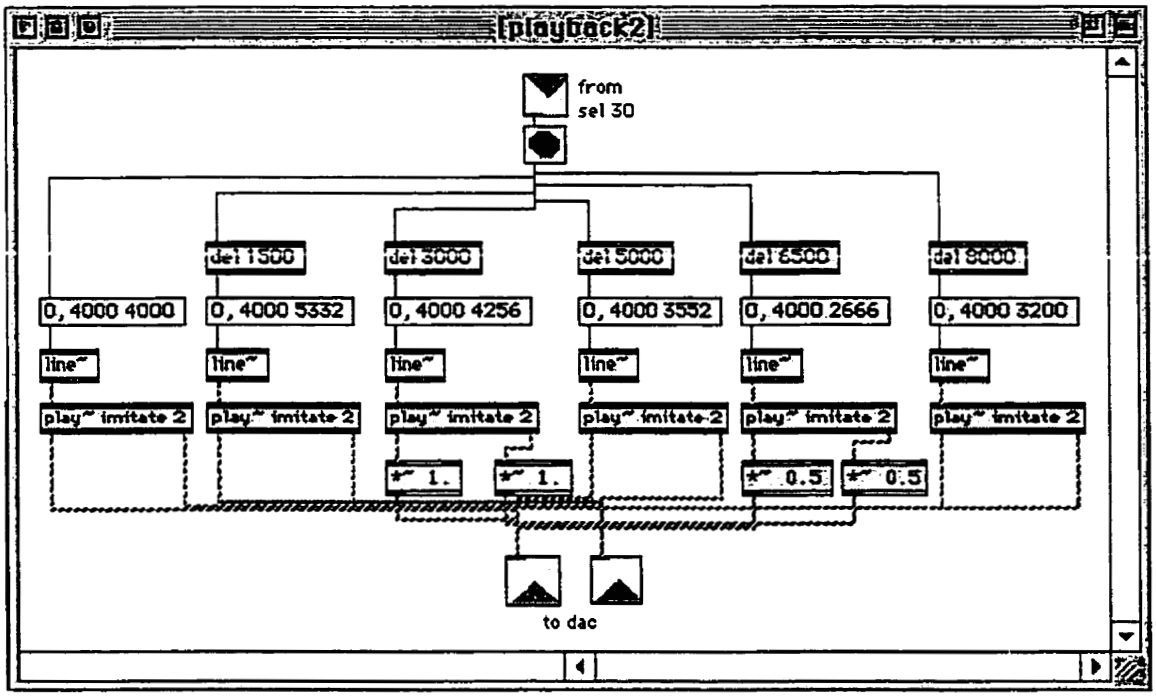
In MAX patch "randomp" the triggering of event #26 first opens the soundfile "imitate.aiff" then plays the soundfile using the **sfplay~** object. After a delay of 1000 ms a bang is sent to start the "panning" patch (see also "panning"). At the same time, this bang opens the gate, thus allowing it to accept input from the **sfplay~** object. The **sfplay~** object outputs a bang when it is finished playing each soundfile. Both the gate and the **counter** objects receive the sfplay~ bangs. The counter uses these bangs to keep a running count of how many soundfiles have been played. When the gate receives the same incoming bang it then passes the signal on to the **random** object which randomly chooses a number between 0 and 3, sends the results to the addition object (which adds that number plus either 22, 26 or 30). The number to be added is determined when the current count of soundfiles played is equal to either 15 or 38. (ie; when 15 soundfiles have been played the **sfplay~** object outputs a bangs changing the addition of 22 to 26, thus resulting in the possible playing of soundfiles #26, 27, 28 or 29) (group 2: ma ma, a ta da, ta da). This patch continues in this way until event #27 is triggered (see Appendix C: "chain")

APPENDIX C: MAX Patches



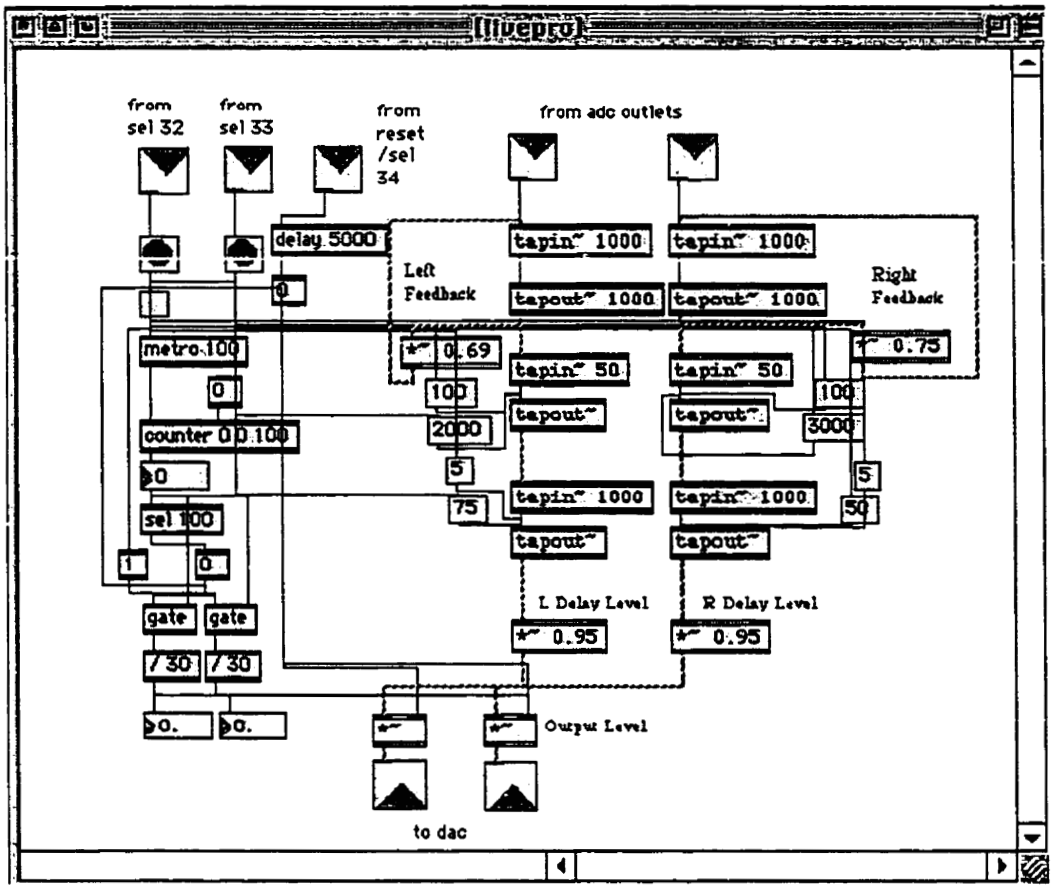
The MAX patch "panning" is a subpatch of "randomp" and controls the panning (left, center, and right) of each soundfile randomly played in the above patch. When the "panning" patch is turned on, a signal is sent to open the gate, which will then receive bangs from the **sfplay~** object, in "randomp", every time a soundfile has finished playing. Once this signal is received, it is passed on to the **random** object, which chooses a number between 0 and 3. The **select** object then selects the random number and sends it to the appropriate location, establishing the panning for the next soundfile played in "randomp".

APPENDIX C: MAX Patches



The MAX patch "playback2" deals with the changing of the pitch of the original sample recorded (Sample 6), playing it back 6 times. Since the "record" patch only records to the buffer for 4 seconds, the following calculations are based on 4000 ms being the length of the soundfile at it's original pitch. When "playback2" is triggered it plays Sample 6 at its original pitch, down a perfect 4th at 1500 ms, down a minor 2nd at 3000 ms, up a major 2nd at 5000 ms, up a perfect 5th at 6500 ms, then up a major 3rd for the last repeat at 8000 ms. To determine the various changes in pitch, a MAX patch "interval conversions" was devised to perform these calculations (see Appendix C: "interval conversions").

APPENDIX C: MAX Patches



In the "livepro" (live processing) MAX patch, selecting event #32 turns on the **metro** object (a metronome). Each bang the **metro** outputs is counted by the **counter** object. The resulting current count is then allowed to pass through the gates so that number can be divided by 30. The resulting floating point number is then sent to the multiplication (*~) object which multiplies the amplitude of the live signal input from the audio digital converter (**adc~**). The outcome of all this is the gradual fading in of the live signal after being passed through programmed processing effects. When event #33 is selected the same process is repeated, this time with new variables for the **tapin/tapout** delay objects. Selecting #32 triggers the numbers 100 and 5 for both the left and right delays, where as selecting #33 changes the variables to 2000 and 75 for the left delay, and 3000 and 50 for the right delay. When event #34 is selected, the naturally decaying sound is delayed for 5000 ms before returning all levels in this patch to normal (0).