SOFTWARE-ASSISTED HARMONIC FUNCTION DISCRIMINATION

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ABSTRACT

Determining the function of chords within a diatonic key can be difficult, especially for those listeners who do not regularly play instruments capable of producing chords. Software-based instruments, however, can allow an individual to play chords by pressing a single button as opposed to plucking several strings or pressing several keys. This quantitative study addressed two research questions: to what extent is a software-based musical instrument able to assist individuals in recognizing chord-contexts to the extent that traditional chordal instruments do? In what ways does a software-based musical instrument compare to a traditional chordal instrument as a viable aid for assisting individuals in chord-determination activities?

In this Pre-/Post-test designed study, two groups of undergraduate music majors using either a chordal instrument or a software-instrument completed activities that emphasized understanding chord progressions. Results were compared within the groups and between groups. Both groups improved to some extent and there was no significant difference between the improvements within both groups overall, suggesting that the software instrument was as viable a mechanism for supporting the musical task as the traditional instrument. Additionally, the data suggest that the ability to recognize two of the five progressions, the vi IV I V and the I V vi IV, improved significantly in the experimental group but not in the control group.

Keywords

Interactive media, music systems, music theory, ear-training, harmony, adaptive instruments, music programming, music technology, music education, informal music learning

INTRODUCTION

Recognizing chords and chord progressions by ear is part of musicianship, yet this is a skill in which many musicians may feel deficient. Players of primarily single-note instruments (like trumpet, voice, and sax) may be more deficient than performers of chordal instruments (like piano and guitar) due to their lack of experience playing chords. In the past, institutions have attempted to teach students to understand harmonic motion and tonal contexts of chords by having them use a piano as an aid, yet, for those who lack the same proficiency on a piano as they do on their primary instrument, more effort is spent on the physical act of performing back the harmony than in actually listening to the harmony, its motion, and the context of each chord in the progression in an attempt to understand it.

This study examined the extent to which software-based musical instruments were able to assist individuals in determining chord-contexts within popular music the way that traditional chordal instruments do.

BACKGROUND

Perception of harmonic chord functions requires that listeners make sense of presented musical material within the context of their prior musical experiences, but even experienced musicians may not immediately identify the quality of harmonic sonorities or their context within a key (West, Howell & Cross, 1985).

Green (2008) outlined a performance strategy hinged on listening to music that is culturally familiar and learning to play the music informally “by ear”. This strategy mimics the behaviors that many popular musicians have learned to perform (Green, 2002). Popular music compositions seem an ideal fit for learning to identify chord function patterns given the amount of repetition that commonly occurs, not to mention other common traits including simplicity of form and phrase, and almost strict adherence to diatonicism. Experimental research in information theory describes aspects of redundancy (Broadbent, 1958; Meyer, 1956, 1967, 2001; Watson, 1973) within a message as a factor in perception. Research suggests that the more information contained in a message without redundancy of elements within the message, the greater the variability of ascertaining meaning or response from the message. The simple, singable diatonic melodies used in much popular music strengthen the tonality of the harmonic accompaniment that supports it as melodic pitch structure is one determinant of tonality (Taylor 1976).

Music educators facilitating the type of student-directed learning thst Green describes must be proficient in the aural discrimination used in determining chords and chord progressions by ear. This skill is not assessed on teacher certification examinations, and the NASM (2012) accreditation mandate for addressing these particular skills in undergraduate and graduate ear-training (aural skills) courses is unclear. Curricular objectives vary from school to school and it is difficult to assess the extent to which a music major possesses this particular skill among other ear-training skills.

Perceptual Organization of Harmony

The perceived psychological relationships of chords in several contexts have been identified by Krumhansl, Bharucha, and Castellano (1982). Structures of perception, as they relate to determining chord progressions, are more than hearing chord qualities, but rather hearing the context of chord sonorities within a key (Krumhansl 1979, 1990; Cuddy 1991).

According to Krumhansl (1990), research suggests that "…internal representation of tonal and harmonic relations is acquired through experience" and is supported by Radocy and Boyle (2003, p. 217). If the conceptualization of these cognitive structures is acquired and developed through experience, then musicians whose primary instrument is incapable of producing harmony could have a deficit in this skill, or will be slower to develop such skills compared to others whose primary instrument is capable of producing harmony.

Software-based Instruments (Interactive Music Systems)

Learning to recognize chord progressions using the assistance of a chordal instrument, like guitar or piano, requires some level of proficiency that allows the listener to produce chords on the instrument. During the process of playing these progressions, the participant should be focusing their attention to hearing the chord progression and the harmonic flow as they are playing and not on the actual task of playing the progression. If asked to play a chord progression, a musician who is unfamiliar with a chordal instrument, might focus most of their attention to ensuring that they are playing the chords correctly and miss the purpose of the activity altogether: hearing what a I V vi IV progression sounds like. Using a software-based musical instrument could remove some of the need for attention to physical performance issues that one might encounter while performing an unfamiliar acoustic chordal instrument.

Separating the physical act of performing from the cognitive function of hearing harmony is important to educators because it allows musicing (Elliott, 1995) to occur by students without making them wait until they have learned the performance skills of a traditional instrument in order to play chords. In this way, playing chords and, conceivably, being able to compose and perform with them can occur much sooner with a software-instrument than with acoustic instruments. By minimizing the number of layers between the student and the task, the musical concept can be isolated to some extent and understood apart from the context of it being performed on a particular instrument.

Purpose

The purpose of this study was to address two research questions: to what extent is a software-based musical instrument able to assist individuals in determining chord-contexts within popular music the way that traditional chordal instruments do? In what ways does a software-based musical instrument compare to a traditional chordal instrument as a viable aid for assisting individuals in chord-determination activities?

This study focused on the use of technology in an effort to separate the cognitive functions of understanding chord functions within progressions from the physical actions involved in performing them. This was accomplished by allowing individuals to use a software-based musical instrument to play diatonic chords instead of a traditional instrument.

Over the course of six weeks, participants in the experimental group were asked to listen to popular music and, using the software as an aid, perform alone and with MP3 audio accompaniment. Additional activities asked participants to determine the chords and the progressions in selected music with and without the aid of the software. Participants in the control group participated in the same activities, but used a traditional acoustic instrument as an aid instead of the software instrument.

In this pre-/post-test designed study, the investigator observed the ways that post-test scores changed after six weeks of study using either software or a traditional instrument as an aid in determining chord progressions. The scores of each group were also compared to each other.

Improving one's ability to determine chord progressions using an interactive music system could yield important implications for further research. In particular, individuals looking to practicing recognizing chords and progressions, but lack mastery performing on a chordal instrument could use such a system as an alternative to learning a traditional instrument. Additionally, open-source software systems, like the one developed and used for this study, can be modified to allow musical events to be triggered using any sort of control mechanism suitable to different individuals including sensors, buttons, and more, and can be expanded to function as a prototype for future research.

METHODOLOGY

Participants

The participants (N = 67) were male and female undergraduate music majors at a mid-size university in the northeast United States. Over 450 music majors at the university were invited to participate in the study and were given the option to receive extra credit in their music theory or aural skills courses as an incentive. In order to obtain baseline data about the participants, a qualifying questionnaire was administered to gather information about the participants' musical background and musical experience prior to college study as well as their current studies. The results of these data were used to identify participants who had proficiency on a chordal instrument and those who did not. Participants were randomly placed into two groups labeled control and experimental with 34 participants in the experimental group and 33 in the control group. The responses of the qualifying questionnaire were analyzed using Fisher's Exact test to ensure that there was no statistical significance between the two groups; both groups contained members with similar musical backgrounds and experiences.

Participants in both groups were given a schedule of activities to complete on their own over the next six weeks as well as the link to complete the pre-test survey. Participants were asked to devote and log 1.5 – 2 hours of their time each week to the activities assigned to them and not to exceed or fall behind this time allotment. Both the experimental and control groups completed the same activities but with different music instruments as an aid: the control group used a traditional chordal instrument, while the experimental group used a software-based interactive music system.

Equipment

The experimental group used custom application called E006 that allows individuals to perform chord functions by pressing the computer number keys 1 – 8 (octave included) to trigger the corresponding diatonic chord functions for a given key.

The software displays a window with the week's activities listed as well as videos demonstrating how to use the software. A typical activity consisted of playing a four-chord progression using the software while reading from chord sheets displaying a chord function number with beat markings beneath it. The software included MP3s of popular songs allowing the participant to play the chords to the song using the software controls (number keys) and reading the chord function numbers from the chord sheets provided while the actual recording played as an accompaniment. The software automatically switched to the key of each selected song allowing participants to continue using the same seven controls (computer keys) despite key changes. The software also selected a timbre that matched the context of the song being performed.

Activities - Experimental Group

For six weeks, the participants in the experimental group completed the activities presented from within the E006 software. The songs used were popular radio songs from the 1960s to 2011 in a variety of styles including rock, pop, R&B, and rap.

In additional analysis activities, participants were asked to listen to a song and, after being given the key and a blank chord sheet with the rhythmic profile, were asked to write down the chord progression using only the software (the control group used an acoustic instrument) as an aid. Additionally, "Name That Progression" activities were introduced where an audio excerpt from a song was played and the participant was asked to name the four-bar chord progression being used by ear without the aid of any instrument. This activity was similar to the one used in the pre/post-tests.

Activities - Control Group

The control group participants were asked to complete the same activities as the experimental group without the aid of the software instrument using, instead, any chordal acoustic instrument of their choosing such as a piano or guitar. After groups were formed, participants in the control group received a link to a website which hosted the similar activities used by the experimental group. Instead of having the option to press a number key on their computer keyboard to play a diatonic chord function, the instructions in these activities asked participants to play the chord progressions using an acoustic instrument such as piano or guitar. As with the experimental group activities, identical chord sheets and MP3s were provided to the participants for the purpose of performing songs with recorded accompaniment.

Compositions

Some song activities presented in the first week were not in any strict progression, but were presented as introductory exercise songs to help familiarize the participant with the activities. As weeks progressed, different 4-bar progressions were used and combinations of progressions were introduced using only diatonic chord functions. Although the software can be used to play chords with added notes beyond the triad, only triads voiced with doublings in a style typical of popular music were used.

In the majority of activities where the participant was asked to play along with an MP3 audio recording; songs requiring only root position chords were primarily used. The use of songs with inversions was limited, but was noted in the chord sheets provided to the participant. In cases where inversions were used, they occurred after the first week of activities and the inverted chords were first inversion V chords.

Test instruments

This study employed a pre-test post-test design using online surveys as the testing instrument. Data were collected via online surveys and the responses by both groups to the pre-test and post-tests were compared. The rate of increase or decrease of the percentages was observed for all self-assessment questions in the pre/post-tests and analyzed using Fisher's Exact test. The rate of increase or decrease of the percentages for each of the five progression pairs was being observed for these listening questions in the pre/post-tests and analyzed using a T-test. Results follow in the Results section and full data are provided online at vjmanzo.com/dissertation.

Pre-test

There was one single pre-test survey given to both the control and experimental groups (see Survey Questions in Appendix A). The surveys began with four self-assessment questions in which participants were asked to rate their current skills for activities related to aural skills and theory comprehension. For both the pre-test and post-test surveys, there were 10 total listening questions, Questions 6 – 15, in which participants were asked to listen to an excerpt of a popular song that prominently featured the performance of a diatonic four chord pattern and select the appropriate chord progression used as displayed in numbers (e.g. 1 5 6 4) from a dropdown menu. For these 10 questions, five progressions appear twice as the correct response. The responses with matching progressions were paired for analysis; for example the correct answer to Questions 9 and 11 on the pre-test was the 1 5 6 4 progression, pair 4, as shown in Table 1 below. Table 1 also shows how the correct responses from the pre-test relate to the correct responses from the post-test.

Table 1.
Pre-test correct responses as they relate to post-test responses

Pre-test Correct Answers Questions 6 - 15	Post-test Correct Answers Questions 6 – 15
Question 6 – 1 4 6 5	Question 10 – 1 4 6 5
Question 7 – 6 4 1 5	Question 7 – 6 4 1 5
Question 8 – 1 6 5 4	Question 11 – 1 6 5 4
Question 9 – 1 5 6 4	Question 6 – 1 5 6 4
Question 10 – 1 4 6 5	Question 12 – 1 4 6 5
Question 11 – 1 5 6 4	Question 9 – 1 5 6 4
Question 12 – 6 4 1 5	Question 13 – 6 4 1 5
Question 13 – 1 6 4 5	Question 8 – 1 6 4 5
Question 14 – 1 6 5 4	Question 15 – 1 6 5 4
Question 15 – 1 6 4 5	Question 14 – 1 6 4 5
Response grouping pairs (for analysis) Pair 1 - 1 4 6 5, Pair 2 - 6 4 1 5, Pair 3 - 1 6 5 4, Pair 4 - 1 5 6 4, Pair 5 - 1 6 4 5	

The pre-test iterations of these questions were the same as the post-test questions with the exception that different audio examples were used on the post-test and that the correct responses to these questions were reordered. An attempt was made to match pre-test songs with post-test songs in terms of harmonic rhythm, tempo, and style. Some songs appearing on the pre-test were

reused for the weekly activities, but no post-test songs were used in the weekly activities.

Post-test

At the completion of the sixth week of activities, participants were emailed the post-test questionnaire identical in design to the pre-test survey with self-assessment questions, and "quiz-style" listening questions. Additional questions, were included on the post-test that did not relate to the pre-test in any way, in which participants were asked to rate their experience completing the activities during the six-week period (see Table 6 Questions 16 – 19). The responses by both groups to these questions were compared.

RESULTS

Self-assessment

The four self-assessment questions from the pre-test also appear on the post-test. The responses to these questions were compared within both groups using Fisher's Exact test. There was no statistical difference found between the perceived rate of improvement responses in either the control or experimental group.

"Quiz-style" listening questions

For both the pre-test and post-test surveys, there were ten total listening questions, Questions 6 – 15, in which five progressions appear twice as the correct.

In the experimental group, there were significant improvements for Pair 2, the 6 4 1 5, and Pair 4, the 1 5 6 4 progression. The correct responses to the questions in which the 6 4 1 5 progression was the correct answer improved 19% from pre-test to post-test as shown below in Table 2. The correct responses to the questions in which the 1 5 6 4 progression was the correct answer improved 15% from pre-test to post-test as shown below in Table 3. Improvement for the remaining question pairs answered by the experimental group had no statistically significant differences and overall among all 10 questions collectively, there was no significant improvement. There was no statistically significant improvement in the scores for any of the listening questions answered by the control group in pairs or collectively.

Table 2

Progression pair 2 (6 4 1 5) 19% improvement in experimental group

N	Mean	Std Dev	Std Err	Minimum	Maximum
34	0.1912	0.3260	0.0559	-0.5000	1.0000
Mean	95%	CL Mean	Std Dev	95% CL	Std Dev
0.1912	0.0774	0.3049	0.3260	0.2630	0.4291
DF		t Value		Pr > |t|	
33		3.42		0.0017	

Table 3

Progression pair 4 (1 5 6 4) 15% improvement in experimental group

N	Mean	Std Dev	Std Err	Minimum	Maximum
34	0.1471	0.3595	0.0617	-0.5000	0.5000
Mean	95%	CL Mean	Std Dev	95% CL	Std Dev
0.1471	0.0216	0.2725	0.3595	0.2900	0.4732
DF		t Value		Pr > |t|	
33		2.39		0.0230	

Post-test extension questions

The responses to the additional post-test questions were compared to each other, and two of the three questions indicate that the control and experimental group have statistically significant differences in the perception of their improvement.

For extension question 1, "To what extent do you feel that your ability to determine chord progressions improved", the results shown in Figure 1 show a statistically significant difference between both sets of scores ($p = 0.0346$) with mixed extents of improvement in both groups. For example, 58.82% participants in the experimental group reported a moderate extent of improvement while 30.30% of control group participants reported the same.

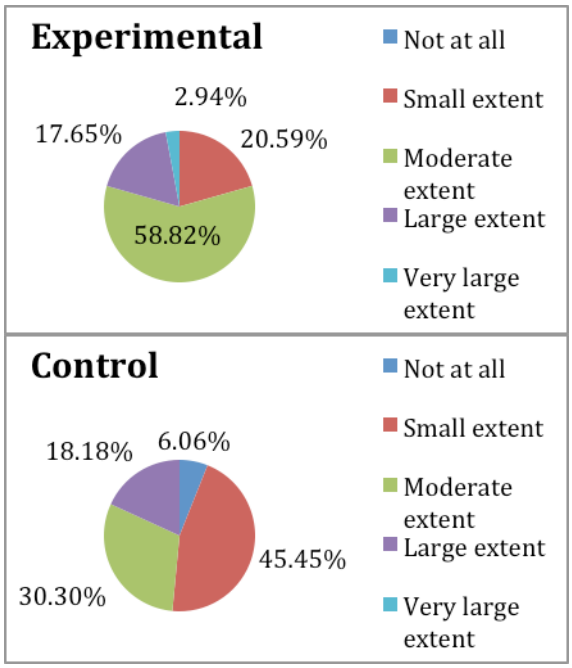

Figure 1. Extension question 1 response: To what extent do you feel that your ability to determine chord progressions improved?

For extension question 2, "To what extent do you feel that using the software instrument / an accompanying instrument (like piano) helped you determine chord progressions", the results show no statistical difference ($p = 0.5157$).

For extension question 3, "To what extent do you feel you would have been able to complete the same activities (determining chord progressions) to the same degree of success without the aid of the software / an accompanying instrument", the results shown in Figure 2 show a statistically significant difference ($p = 0.0249$) with mixed extents of improvement in both groups. For example, a 21.21% of control group participants reported "Not at all" while 0% of experimental group participants reported the same.

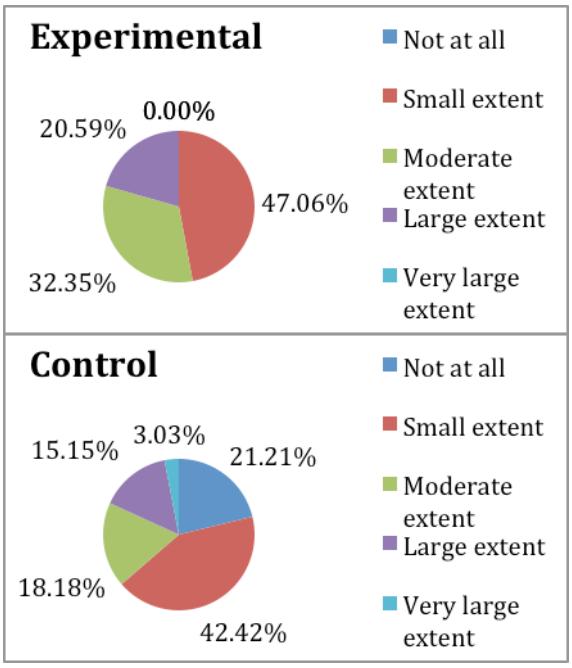

Figure 2. Extension question 3 response: To what extent do you feel you would have been able to complete the same activities (determining chord progressions) to the same degree of success without the aid of the software / an accompanying instrument?

Question 19 was an open response question that need not be compared between the two groups. This question was optional and comments were mixed with some noting the technical ease or difficulties they encountered operating the software such as this response:

> *I consistently felt as if I was guessing half the time though I will say I feel as if my ability to identify chord progressions in root position has improved. First inversion chords still confuse me because I rely on the bass line to determine chords and I often second guess my answers when there is a first inversion chord present since I still feel as if I am guessing. I would have liked more than 2 hours a week to work on these.*

Others mentioned that they noticed an improvement in their abilities exemplified by this comment from an experimental group participant: "So cool and greatly beneficial! I learned chords extremely fast because of this software. I feel it helped me more then me actually sitting in a classroom and learning this from a teacher."

Others noted the pedagogical implications of the activities: "I feel that this method would convey basic music theory much easier to the lay listener. Seems like it would be very useful for all scholastic levels. "

DISCUSSION

The purpose of this study was to examine the effects of activities involving chordal interactive music systems on participants' ability to determine chords and progressions. The effects were observed using a pre-test/post-test design and the results were mixed.

Regarding the pre/post-test self-assessment questions, while both groups generally reported a perceived improvement in their abilities from the pre-test to the post-test, no statistical difference was found between the perceived rate of improvement responses for the control versus the experimental group. This is noteworthy because, although the questions themselves are subjective to the participant, the data suggests that there was no difference between the two groups in the perceived amount of improvement over the course of six weeks. An argument could be made that the software instrument was as viable as the traditional chordal instrument in its role as an aid for the activities as perceived by the participants.

Of importance to this study is the understanding that the self-assessment responses are the subjective opinions from the participants themselves. It is valuable to understand these points of view and compare them to the empirical results from the listening section in which their skills are assessed.

In designing the listening assessment portion of the surveys, I expected that the post-test scores for the experimental group would follow one of three conclusions: 1) the post-test scores would improve, 2) stay the same, or, 3) decline. It was my assumption that the control group scores would improve as one would normally expect given these types of activities. Determining the degree of improvement, if any, was also important to me as I hoped that the scores of the experimental group would improve at least as much as the scores of the control group. This might suggest that a software-based instrument could be as viable in aiding in this activity as a traditional chordal instrument, bearing with it all of the benefits of a software-based instrument which include accessibility, portability, and other aspects described previously. As the data show, results from the post-test for both groups primarily improved and there was no significant difference between the improvements within both groups overall. Additionally, the data suggest that the ability to recognize two of the progressions, the vi IV I V and the I V vi IV, improved significantly in the experimental group but not in the control group.

Among the comments to Question 19 of the post-test survey, one of the ones I found to be most insightful came from a control group member:

Because I'm not all that good at piano for a while I spent the time trying the [sic] get the chords (so basically I spent the time practicing technical things) which left me less time to really think about the sounds. I can hear chord changes now which is a HUGE improvement for me. I'd like to continue the exercises to see if I can better identify the chords with more practice. Right now I can hear the chords and the changes but I have trouble telling which chord it is.

This comment reinforces one of the core focuses of the study. Had this individual been able to use an instrument that was suited for the task and accessible, more attention could be placed on the cognitive operation and not on the physical mechanics of performance. It is this separation of physical actions from cognitive processes that seems to be addressed, at least to some degree, by the creation of software-based instruments. Future research is needed to explore musical aspects not addressed in this study. There are obviously many more common chord progressions used in popular music that were not introduced or assessed. Similar activities using these progressions could yield conflicting or confirming results. Additionally, activities that address different non-diatonic harmony, modes, mode mixture, and chord inversions can be targeted with the same approach in

the attempt to improve recognition. I am also interested in replicating this study with non-musicians. With the understanding that perceiving harmony on different levels is a learned skill as suggested by Serafine (1983), perhaps similar systems and activities can help musicians with the acquisition of this skill.

The notion of attempting to separate the physical actions involved in music making from the cognitive processes is worthy of more investigation. As technology continues to develop, the instrument as a physical "layer" between a cognitive process and the production of a related musical event may become more transparent. This layer will likely dissipate as the design of control mechanisms become more user-centered in terms of accessibility related to specific musical tasks as opposed to the traditional design of instruments being acoustically-centered; instrument design in terms of what will produce the best timbre and the loudest volume as opposed to physical gesture efficiency and accessibility.

Among other previously discussed issues of instrument design and accessibility, an electronic instrument can be much easier to play than a traditional instrument like the violin simply because the capacity for advancements in electronic instruments is far greater than that of traditional instruments. The open-architecture of technology-based instruments, particularly those that are primarily software-based with interchangeable hardware controls, can allow an individual to customize an instrument for any performer, performance environment, or performance application.

Musical concepts are often introduced to beginning music students using instruments of simple design such as in the Orff approach. These Orff instruments are easy to play, in principle, much easier than a violin, but limited in terms of the number of musical variables one can control compared to other acoustic instruments such as the violin. However, as a result of electronic technology, accessibility in terms of ease of instrument playability does not need to be a determining factor in musical sophistication any longer.

The viability of software systems like E006 could have considerable implications for music education. If software systems can be implemented in pedagogical situations where there is little difference in terms of their role in serving an instructional, compositional, or performance objective compared to traditional instruments, considerations like body-type, physical ability, accessibility, and so on, can, instead, become determinant factors regarding instrument use and design. Instrument creation can be designed to fit specific activities.

BIOGRAPHIES

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Appendix A – Survey Questions
(Note: the layout of these surveys online differed from what is shown below)

1.1 Qualifying Survey Questions
Table 4

Question 1. Please enter your name and e-mail address, so that we may notify you if you qualify for this study (information will not be used for any other purpose).									
Response:									
Name:									
Email address:									
Question 2. What is your primary instrument?									
Response:									
Piano or another keyboard instrument (like organ)	Guitar or another polyphonic string instrument (like harp)	Primarily monophonic String instruments (like violin, viola, cello, bass, electric bass)	Voice	Woodwind instrument (like flute, bassoon, or clarinet)	Brass Instrument (like trumpet, trombone, or tuba)	Non-pitched or pitched-monophonic Percussion instrument (like drums, cymbals, or timpani)	Pitched polyphonic Percussion instrument (like marimba, xylophone,	Other monophonic instrument	Other polyphonic instrument

Question 3. Prior to college study, what instrument(s) did you play and for how many years did you play it (them)? Please list the instrument on which you are most proficient first and rate your ability to perform on this instrument.		
Response:		
Primary Instrument		
Instrument Type or Family	# of years played	Ability
Piano or another keyboard instrument (like organ) Guitar or another polyphonic string instrument (like harp) Primarily monophonic String instruments (like violin, viola, cello, bass, electric bass) Voice Woodwind instrument (like flute, bassoon, or clarinet) Brass Instrument (like trumpet, trombone, or tuba) Non-pitched or pitched-monophonic Percussion instrument (like drums, cymbals, or timpani) Pitched polyphonic Percussion instrument (like marimba, xylophone, Other monophonic instrument Other polyphonic instrument	less than 1 1 2 3 4 5 or more	Very Weak Weak Intermediate Strong Very Strong
Instrument 2		
Instrument Type or Family	# of years played	Ability
Instrument 3		
Instrument Type or Family	# of years played	Ability
Instrument 4		
Instrument Type or Family	# of years played	Ability

1.2 Pre-test Survey Questions
Table 5

Question 1. Please enter your name and e-mail address, so that we may notify you if you qualify for this study (information will not be used for solicitation).
Question 2. Please rate your current skills regarding your ability to, by ear, determine the chord progression being used in a typical popular song on the radio: *For example, could you determine: "The chorus of that Journey song is a "I V vi IV" progression repeated 4 times"*
Response Q 3 - 5: Very Weak, Weak, Moderate, Strong, Very Strong
Question 3. Please rate your current overall skills in music theory:
Question 4. Please rate your current skills regarding your ability to, on-the-spot (i.e. "by ear"), choose chords to harmonize a primarily diatonic melody being performed live:
Question 5. Please rate your current skills regarding your ability to choose chords to harmonize a primarily diatonic melody written on staff paper:
Questions 6-15. Please listen to this audio example (below) and, by ear, select the closest matching chord progression from the choices below. Choose chord numbers assuming that each song is in a major key (e.g.: in C Major - 1 = C maj, 2 - dmin, 3 = emin, etc.). PLEASE - don't use any instrument or other aid to assist you in this.
Response Q 6 - 15: 1 4 2 5, 1 4 6 5, 1 5 6 4, 1 5 4 6, 1 6 4 5, 1 6 5 4, 6 4 1 5, 6 5 1 4, 2 5 1 6, 2 1 5 6, I don't know

Post-test Survey Questions

Table 6

Question 1. Please enter your name and e-mail address, so that we may notify you if you qualify for this study (information will not be used for solicitation).
Question 3. Please rate your current overall skills in music theory:
Response Q 3 - 5: Very Weak, Weak, Moderate, Strong, Very Strong
Question 4. Please rate your current skills regarding your ability to, on-the-spot (i.e. "by ear"), choose chords to harmonize a primarily diatonic melody being performed live:
Question 5. Please rate your current skills regarding your ability to choose chords to harmonize a primarily diatonic melody written on staff paper:
Questions 6-15. Please listen to this audio example (below) and, by ear, select the closest matching chord progression from the choices below. Choose chord numbers assuming that each song is in a major key (e.g.: in C Major - 1 = C maj, 2 - dmin, 3 = emin, etc.). PLEASE - don't use any instrument or other aid to assist you in this.
Response Q 6-15: 1 4 2 5, 1 4 6 5, 1 5 6 4, 1 5 4 6, 1 6 4 5, 1 6 5 4, 6 4 1 5, 6 5 1 4, 2 5 1 6, 2 1 5 6, I don't know
Question 16. To what extent do you feel that your ability to determine chord progressions improved?
Response Q 16 - 18: Not at all, Small Extent, Moderate Extent, Large Extent, Very Large Extent
Question 17: To what extent do you feel that using an accompanying instrument (like piano) [or software instrument] helped you determine chord progressions?
Question 18. To what extent do you feel you would have been able to complete the same activities (determining chord progressions) to the same degree of success without the aid of an accompanying instrument [or software instrument]?
Question 19. Please share any comments about the activities in this study.