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An Instrumental Approach to Sight Singing: The Use of Mock-Fingerings

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By

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Abstract

This pilot study was designed to test whether mock-fingerings could be a beneficial strategy for sight singing. The researcher hypothesized that mock-fingerings would help students to be more accurate sight singers. Participants, wind instrument players at the college level, were asked to sight read two examples, one while "fingering along" and one with their hands still. Mean scores were compared among music majors and non-majors, and it was found that the mock-fingerings did not have a significant effect on the mean scores of participants. The mean scores were often comparable between the fingering condition and the control condition, suggesting that the effects of mock-fingerings are unclear and may depend on personal preference.

Introduction

Sight singing is an integral skill in all choral settings. If a musician can sight sing, they can transform symbols written on a page into sung pitches without having to hear the pitches played for them first. In a choral setting, this is important because it saves time in the rehearsal, improves accuracy, and builds literate musicians (Bowyer, 2015; Weary, 2012). In this study, we are particularly interested in the relationship between wind instrumentalists and their sight singing skills. The sight singing strategy found within this study is referred to as "mock-fingering." The term "mock-fingering" is used to indicate an instrumentalist moving their fingers as if playing their instrument, but without the instrument in their hands.

There are two reasons why sight singing may be valuable for instrumentalists. First, sight singing may have a direct positive impact on instrumentalists by improving instrumentalists' ear training abilities (Rawlins, 2005; Hiott & Cross, 2006). For example, Robert Rawlins (2005) writes that "singing is the only true test to see if the instrumentalist actually can hear the music being played with the mind's ear" (p. 27). Second, sight singing skills may be otherwise relevant to wind instrumentalists because of their concurrent or future involvement in choral activities.

Sight singing is a learned skill, with many different pedagogical approaches. Some of these approaches may involve the use of kinesthetics, such as Curwen hand signs. For instrumentalists, however, kinesthetic connections already exist within music. For example, trumpets have three valves, and different notes are produced by changing the combination of valves pressed. Additionally, these kinesthetic connections may exist beyond the bounds of active music-playing. As the primary researcher, I became interested in this topic when I noticed that many instrumentalists regularly mock-finger their instruments. This activity may exist as a form of practice or as a mindless habit. Interest in this topic was further stimulated when I noticed that instrumentalists who also perform as vocalists (including myself) often mock-finger as they sing. I hypothesized that these mock-fingerings may exist as kinesthetic connections between written notes and performed music, and that they may be used to facilitate sight singing. This research project is aimed at discovering whether these pre-existing kinesthetic connections can be used to facilitate the sight singing process.

Knowledge of the use of mock-fingerings as a potential sight singing strategy may have an impact in music education classrooms. Because sight singing is such an integral part of the choral process, choral music educators should be constantly searching for strategies that their students can use to improve their sight singing skills. There are a multitude of existing prevalent sight singing strategies—namely fixed do, moveable do, and scale degree numbers—and no single strategy has been empirically been shown to be the best for all singers, which may imply that the success of sight singing strategies may partially depend on context or individual student characteristics (Frey-Clark, 2017). If this is the case, choral music educators should be willing to think creatively when helping students develop their personal sight singing strategies.

Literature Review

Audiation is an integral concept in the development of music skills (Hiatt & Cross, 2006). Audiation is defined as “music thinking,” or the ability to hear music in one’s mind that may not have been previously present (Valerio, n.d.). Audiation skills are connected with the ability to read music, a skill that may be referred to as notational audition (Hiatt & Cross, 2006). If a person is reading written music, in order to sing a melody out loud, a person must have ‘heard’ it internally first (Kirnarskaya, 2009). Kirnarskaya (2009) writes, “The more active a musician’s internal ear, the better he sight reads and the higher are his musical abilities” (p. 159). Sight reading—the ability to see a piece of music and immediately execute it without previous rehearsal— is a difficult task for almost all musicians. It is not unlike reading a book at sight, but with one key difference: while sight reading language is common and necessary in our culture, sight reading music does not hold this same status (Sloboda, 1985). Sloboda (1985) further points out that "…music reading requires the execution of a complex response where there is very little latitude for deviations in timing and quality" (p. 68). Part of that "complex response" is the need for well-developed control over small muscle movements needed to play almost any instrument (Wilson, 1986). Think about playing the saxophone, which requires the active involvement of all ten fingers in countless combinations. How does this refined movement relate to musicians' ability to audiate, and ultimately to their ability to sight read?

The topic of this research is strongly related to the question of whether audiation skills can be aided by movement skills. We will first explore aural-spatial associations. Studies have shown a correlation between a high level of musical ability and a high level of spatial intellect (Kirnarskaya, 2009, p. 124). When we consider pitch relations, we often describe them in spatial terms: high, low, rising, falling, etc. Kirnarskaya (2009) writes:

> A special area was discovered in the right hemisphere of the brain which is responsible for the reading of musical scores…Much of the data demonstrate that our accepted understandings of 'high' and 'low', rising and falling, taking off and receding and other definitions of musical pitch are by no means metaphors. The sense of musical pitch is closely tied with spatial sensations…So the analytical ear…makes music a spatial variety of art. (p. 125)

Furthermore, this audio spatial relationship is also important to our experience of intervallic relationships (Kirnarskaya, 2009).

Many music educators also agree that this aural-spatial relationship is important in music learning. For certain musical pedagogical approaches such as Orff-Schulwerk, movement is an integral component of music learning (Shamrock, n.d.). Another pedagogical approach that emphasizes movement is the Suzuki method. In strings playing, “the student must learn to associate the physical motions used to produce sound on the instrument with a mental sense of pitch” (Hiott & Cross, 2006). Allison Maerker Garner, a private Suzuki instructor, writes about her experiences using spatial relations and movement in her approach to teaching violin and piano:

> I use creative movement to establish beat, pulse, musical character, and articulation and to illustrate differences in high and low, fast and slow, and loud and soft… I encourage them to walk, run, jump, gallop, and skip in response to what they hear. Changes in body level demonstrate high and low pitch…[and they] move their bodies to what they hear: staccato, legato, accented, slurred, and so on. (Maerker Garner, 2009, p. 47)

Maerker Garner (2009) argues that movement can be a powerful teaching tool for developing musicians. In fact, she defines movement as “audiation through the body” (p. 47) and singing as “audiation through the voice” (p. 48). Although Maerker Garner argues that movement and singing are both important components of audiation skill, she does not make any statements about the relationship or connection between the two.

Kinesthetic associations and the motor system are shown to be directly related to musical activity. Wilson (1986) writes that “[w]hen the interaction is between the musician and an instrument, the muscular system becomes a synthesizer of combined output for a host of neurologic subsystems involved in hearing, vision, movement, language, and emotion” (pp. 27-8). The muscular system (and neurologic processes involved in movement) are essential to any musician's ability to play their instrument. The nature of the relationship between movement and audiation is unclear, but the existence of a relationship is evident. Furthermore, neuroscience research has shown that musicians experience structural change in motor areas of the brain compared to non-musicians. In a 2003 study, Gaser and Schlaug found that in motor areas, including the primary motor cortex, there was a positive correlation between musical ability and an increase in volume of gray matter (p. 9242). However, we cannot say that this shows a direct correlation between audiation and movement skills, only a potential one.

In a 1971 experiment by Vladimir Avratiner (cited in Kirnarskaya, 2009), accomplished pianists were asked to notate memorized pieces using only their internal audiation of the piece as a guide. The pianists struggled, implicating their need to call on muscle-memory in order to actively recall their pieces. They needed to be able to move their fingers: "[T]he majority of students could not write anything down… [because] their musical images were predominantly motor-spatial in character" (Kirnarskaya, 2009, p. 159). Sloboda (1985) presents his thoughts on how this motor-spatial relationship might function: "[S]killed human performance is seldom a rigid movement sequence…[but] is the result of an interaction between a mental *plan* which specifies features of the intended output and a flexible programming system" that determines the necessary muscle contractions in order to achieve a particular musical output (p. 89). Part of that mental plan may very well be the internal audiation of the music.

Let us now explore one common singing strategy that directly connects movements to pitches: Curwen hand signs. These are the hand signs that correspond with solfege syllables, and they are a regularly utilized pedagogical method in choirs of all ages. Essentially, Curwen hand signs are kinesthetic representations of pitch relationships within a scale. Advocates claim that hand signs form a connection between the musical pitch and the kinesthetic learning modality

(McClung, 2008, p. 257) However, according to current research, hand signs have very little effect, positive or negative, on the accuracy of pitches when sight singing (Frey-Clark, 2017; McClung, 2008). An exception is found in one interesting situation: in a 2008 study by Alan McClung, students who used hand signs scored higher on sight singing exercises if they also played an instrument (McClung, p. 262-3). He speculates that one explanation for this result may be “a possible connection between the kinesthetic skills required to play an instrument and the kinesthetic skills required to use Curwen hand signs effectively” (McClung, 2008, p. 263). This raises further questions: Do instrumentalists tend to be kinesthetic learners? If so, can applying a kinesthetic modality be beneficial to instrumentalists’ abilities to sing?

We can see that the research on the relationship between audiation and movement is largely non-specific and often inconclusive. Many theorists imply a connection, but Frey-Clark (2017) and McClung’s (2008) research show that in most cases, kinesthetic connections designed to relate to pitch neither significantly help nor hurt the pitch accuracy of sight singers. Ultimately, more questions are raised than answered. One of the purposes of the following research is to explore a specific component of the relationship between movement and audiation: the relationship between mock-fingerings and sight singing.

Methodology

Population

The sample population consisted of music and non-music majors who play a wind instrument at the University of South Carolina. The students were drawn from the University Band, Symphonic Winds, and the Carolina Band (the marching ensemble). The sample consisted of 45 students, with 11 non-music majors and 34 music majors. A questionnaire survey was

Table 1

Demographics of Sample Population

Characteristic	Music major		Non-music major		Full sample	
	n	%	n	%	n	%
Instrument						
Baritone/Euphonium	1	2.9	2	18.2	3	6.7
Bassoon	1	2.9	0	0	1	2.2
Clarinet	9	26.5	3	27.3	12	26.7
Flute	2	5.9	0	0	2	4.4
French Horn	7	20.6	0	0	7	15.6
Oboe	2	5.9	0	0	2	4.4
Piano[a]	0	0	1	9.1	1	2.2
Saxophone	1	2.9	4	36.4	5	11.1
Trombone	1	2.9	0	0	1	2.2
Trumpet	8	23.5	1	9.1	9	20.0
Tuba	2	5.9	0	0	2	4.4
Years played instrument						
<5	3	8.8	0	0	3	6.7
5-7	4	11.8	2	18.2	6	13.3
8-10	18	52.9	7	63.6	25	55.6
>10	9	26.5	2	18.2	11	24.4
Previous sight singing experience						

Characteristic	Music major		Non-music major		Full sample	
Aural Skills	27	79.4	1	9.1	28	62.2
Choir	2	5.9	1	9.1	3	6.7
Aural Skills and choir	4	11.8	0	0	4	8.9
None	0	0	9	81.8	9	20.0
Other	1	2.9	0	0	1	2.2

[a]Although the study was designed for wind players, one pianist participated without the researcher's prior knowledge.

conducted of the sample, noting students' primary instrument, years played, and previous sight singing experience. This information is found in Table 1.

Method

At the onset of the experiment, each participant was individually read an identical script by the proctor. This script can be found in Appendix A. Before each example, the participant was played a tonic triad and given a thirty second silent study period. Each participant saw two examples, A and B. They performed one example while mock-fingering as if playing their instrument (F condition) and the other example with their hands still (C condition). The order in which each participant saw each musical example and performed each condition was controlled by the experimenter. The first participant read example A under the F condition first. The next began with B under the F condition. The third began with A under the C condition, and the fourth began with B under the C condition. This pattern was continued repeatedly throughout the experiment.

After the participant finished sight reading, they were given a questionnaire to fill out (found in Appendix B). Most questions were demographic in nature, as noted in Table 1, but one question was open-ended, asking participants whether they had used mock fingerings to help them sing in the past.

All participants were given small gift cards or coupons as incentives for participating. These gift cards/coupons were donated by the following local vendors: Starbucks, Pawley's Front Porch, Marco's Pizza, and Pita's Mediterranean Restaurant.

When the experiment was conducted, participants sat in a small practice room with the proctor. A blind audition format was not used; the proctor and the participant could see one another. (This was necessary for the proctor to verify that the participant was adhering to the F or C condition rules.) However, the experiment was designed to resemble a double-blind procedure as closely as possible. At the time of the experiment, the examples were simply recorded. They were scored at a later date, about three months following the experiment. When the examples were scored, the scorer was unaware of who was being scored, or which condition was being scored. However, the scorer and the proctor were the same person, so some knowledge of participants may have been retained. Additionally, although the participants each experienced both the F and C conditions (negating a characteristic of a true double-blind experiment), the participants were unaware of the purpose of the study in an attempt to reduce the effects of researcher bias.

Most examples were recorded using the Voice Memos app on an iPhone 6S. However, 9 participants were recorded using the Voice Recorder application on an HP laptop.

Design of Examples

All examples were newly composed for the purposes of this project. It was decided that the music majors should read more challenging examples than the non-music majors, because all music majors are required to take classes that specifically train sight singing and other aural skills (see Table 1). Since most non-majors have not taken this class, the two groups were split, and different examples were composed. All examples were eight measures in length and in 4/4 time. One example (MM Example B) contained a one-beat anacrusis. All examples were written in the key of D-major, began and ended on the tonic note, and contained melodies that stayed within the range of a sixth. The sight singing examples are shown in Figures 1-4.

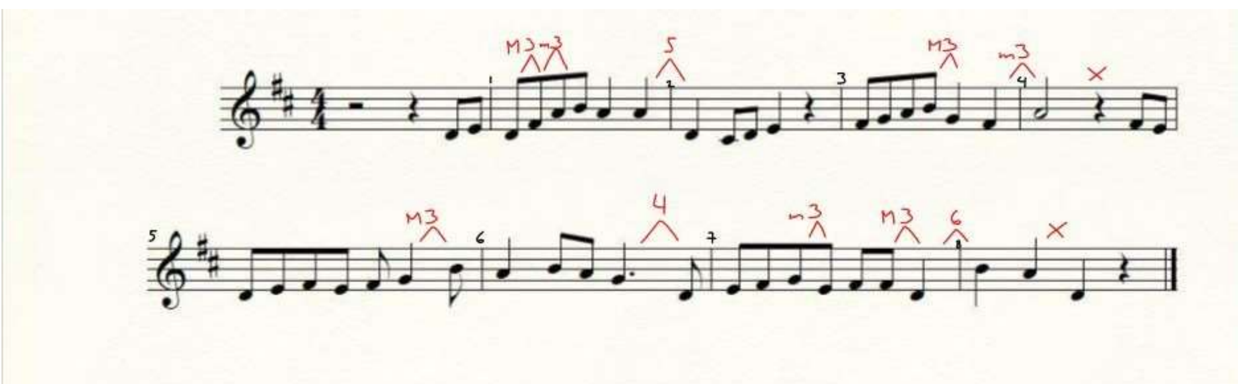
The examples were written to be analogous in difficulty levels based on certain pre-determined factors. These equivalency factors were based on the system used by McClung (2008) in his research on the effectiveness of Curwen hand signs. The non-major example equivalence factors were: use of only diatonic pitches; use of mostly stepwise motion; four leaps of a third (major/minor unspecified); and rhythmic inclusion of only dotted half notes, half notes, quarter notes, and eighth notes (without syncopation). The music major example equivalence factors were: use of only diatonic pitches; use of mostly stepwise motion; seven leaps of a third (major/minor unspecified), one leap of a perfect fifth, one leap of a perfect fourth, and one leap of a major sixth; and rhythmic inclusion of half notes, dotted quarter notes, quarter notes, and eighth notes (with syncopation). Note that a mistake was made in MM Example B, which contained an additional leap of a third and an additional leap of a fifth. Neither of these extra leaps were scored.

Figure 1

Music Major Example A

Figure 2

Music Major Example B[a]



[a]Two mistakenly included leaps are marked with an X and were not included in the interval score.

Figure 3

Non-Music Major Example A

Figure 4

Non-Music Major Example B

Although all examples were written in D-major, this study was not interested in the effects of key signature and range. Therefore, participants were allowed to request a key change if the example was not in a range that suited their voice. Only one participant chose to change the key of their performance, and the key was lowered to A-major for this participant.

Scoring System

For each example, participants earned points in three categories: pitch accuracy, rhythm accuracy, and targeted interval skills. Pitch accuracy and rhythm accuracy were scored by measure. Every example contained eight measures, so for each example, a participant could earn up to eight pitch points and eight rhythm points. One example (MM Example B) contained a one-beat anacrusis. For scoring purposes, the anacrusis was considered to be part of the final measure of that example (which itself only contained three beats). If any error in pitch occurred in a measure, the participant did not receive a pitch point for that measure. If any error in rhythm occurred in a measure, the participant did not receive a rhythm point for that measure.

The targeted interval skills were different for music majors and non-majors. For music majors, the targeted interval skills included seven 3rds (major or minor not specified), one perfect 5th, one perfect 4th, and one major 6th, for a total of ten possible points. For non-majors, the targeted interval skills included four 3rds (major or minor not specified), for a total of four possible points.

Targeted interval skills were separated from the pitch skills because the researchers believed that the kinesthetic effects could differ for absolute pitch considerations versus the interval relationships between notes. This was for two reasons.

First, tonicization and maintaining key feeling have been shown to be effective strategies for highly successful sight singers (Killian & Henry, 2005). However, many of the participants in this study were not highly successful sight singers, so maintaining the key was not always a successfully performed skill. In other words, many participants “lost do” during their performance, and therefore moved the melody in the correct contour, but did not always sing the correct pitches. However, in scoring interval scores separately, participants received credit for accurately related leaps, even if the notes they were singing were not accurate.

Second, as will be discussed later, many of the participants play transposing instruments (instruments pitched in a key other than C). For this reason, the researchers hypothesized that the kinesthetic movements of the mock fingerings might be better related to interval relationships than to absolute pitch.

Pitch Scoring Considerations

For the purposes of this study, no attempt was made to account for intonation discrepancies. Pitches were sometimes sung out of tune, but if in the context of the example they functioned as and sounded close enough to the correct pitch, they were counted as correct. This discrimination was based on human judgement only, and some error is likely.

If a participant modulated to another key, their new "do" was considered to be correct, and the rest of the example was graded as if it was in that new key. A student who changed keys once within the example was penalized one point from their total pitch score. If they changed keys twice, they were penalized two points, and so on. Determining whether a student had in fact modulated, or whether they had simply sung incorrect notes, was based on the preceding and following context of their performance. If the participant began the example in a key other than D-major and continued consistently in that key, they were not penalized.

Rhythm Scoring Considerations

Rhythmic accuracy and hesitations had to be separated in the scoring of the examples. A "hesitation" was defined as a break in the flow of an example that did not necessarily correspond with inaccuracy of rhythm. A separate "Flow Deduction Rubric" was created, shown in Table 2.

Table 2

Flow Deduction Rubric

Participant Hesitations	Points Deducted
Consistent Tempo	-0
One Hesitation	-1
Occasional Hesitation (2-3)	-2
Frequent Hesitations (4 or more)	-3

Flow points were deducted from the overall rhythm score. If a participant hesitated during a measure, but the rhythm was otherwise accurate, they received a rhythm point for that measure, but the hesitation was tallied into their flow point deduction. The scorer erred on the side of counting breaks in the rhythm as hesitations as opposed to rhythm imprecision, unless the rhythm itself was obviously incorrect. There was no objective system for determining the difference between hesitations/rhythmic imprecision and ill-timed breathing. The scorer attempted to determine whether or not the participant was simply taking a breath, but some error is likely in this consideration.

Targeted Interval Skills

When scoring for targeted interval skills, each interval was worth one point. Each non-major example contained four scored intervals, and each major example contained ten scored intervals. The interval breakdown is presented above. When grading whether an interval was correctly achieved, the objective relationship between the two notes in question was the only criteria. For example, when grading a perfect 5th interval, if the distance between the two notes was a perfect 5th, the interval was correct. The correctness of the pitches themselves in the context of the example was not considered in this score. Thus, if a participant sang two wrong notes but they were a perfect 5th apart, they still received the targeted interval point. In this way, it was possible for participants to receive a targeted interval point located in a measure in which they did not receive a pitch point. When grading 3rds in this manner the performed interval had to be the correct kind of 3rd in order to receive a point. For example, if a major third was written but a minor third was sung, the participant did not receive a point for that interval. Again, the interval score did not consider the absolute correctness of the pitch; it only considered the relationship between two sung pitches.

Reliability

20% of the examples (9 participants) were randomly selected by a number generator (random.org) and re-graded by an outside source, a fellow undergraduate music education major with perfect pitch. She was presented with the above scoring guide, along with the rubric sheet that was used to grade each participant (found in Appendix C). The participant examples re-scored were participants 7, 10, 11, 12, 16, 21, 28, 36, and 42.

The re-scored example scores were compared to the original scores using a correlation test. The overall correlation coefficient was found to be 0.903. Thus, the scoring system used in this experiment was shown to be reliable. The correlation coefficients for each separate scoring category can be found in Table 3.

Table 3

Correlation Coefficients for Re-scored Examples

Category	Correlation Coefficient
F Condition	
Pitch	0.985
Rhythm	0.848
Interval	0.961
C Condition	
Pitch	0.989
Rhythm	0.769
Interval	0.862

Results

Due to limitations within the data (further addressed in the discussion), the researchers decided to analyze descriptive statistics only. The mean scores and standard deviations for each category were calculated. Additionally, because the music major and non-music major scoring systems and musical examples are not comparable, their results must remain separate and cannot be contrasted with each other.

Table 4 shows the descriptive data collected for the scores of both music majors and non-music majors. Among music majors, there is no clear trend when comparing mean Fingering (F) scores to Control (C) scores. Mean pitch scores were greater in the F condition, but rhythm and

Table 4

General Results

Condition	Pitch[a]		Rhythm[b]		Interval[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
			Music Majors (n=34)			
Fingering (F)	3.85	2.84	5.62	1.78	5.47	2.96
Control (C)	3.68	2.66	5.65	1.79	5.85	2.56
			Non-Music Majors (n=11)			
Fingering (F)	2.45	2.81	6.82	.87	1.00	1.18
Control (C)	2.73	2.20	6.91	1.76	1.64	1.69

[a]Pitch scores ranged from 0-8. [b]Rhythm scores ranged from 0-8. [c]For music majors, interval scores ranged from 0-10. For non-music majors, interval scores ranged from 0-4.

interval scores were lower in the F condition. Among non-music majors, all mean C scores were greater than F scores. The non-music major trends seem to refute the hypothesis that mock-fingerings will improve sight singing scores. However, it is worth noting that the differences between all scores were not extensive, indicating that the F condition made little difference (positive or negative) for the average participant. This is consistent with previous research on the effectiveness of Curwen hand signs (Frey-Clark, 2017; McClung, 2008).

Due to the inconclusive data presented above and the potential confounding variables found within this study, the researchers decided to divide the data further by two potential covariates: whether or not a participant used solfege; and whether the participant played a transposing instrument or an instrument pitched in C. Because no non-music majors used solfege, the solfege data is limited to music majors only. Solfege data is presented in Table 5, and transposition data is presented in Table 6. The transposition data also includes only music majors, because when the non-music major data was separated by transposition, the n values were deemed too small to produce significant data.

Table 5 shows that in all cases, the mean scores for pitch and interval are greater in the condition with solfege than the condition without solfege. However, the mean scores for rhythm are greater without solfege. This data intuitively makes sense, as solfege is a system designed to aid pitch skills, not rhythm skills. The use of solfege to aid sight singers is championed by many music educators, and is found throughout the literature (Weary, 2008; Frey-Clark, 2017; Cassidy, 1993). However, the evidence-based effectiveness of solfege compared to other pitch systems is still in question (Frey-Clark, 2017).

Table 5

Solfege Data (Music Majors Only)

Condition	Pitch		Rhythm		Interval	
	M	*SD*	*M*	*SD*	*M*	*SD*
Without Solfege (n=14)						
Fingering (F)	3.43	2.74	6.64	1.23	4.71	3.08
Control (C)	3.64	2.55	6.36	1.59	5.43	2.58
With Solfege (n=20)						
Fingering (F)	4.45	2.77	4.85	1.65	5.95	2.73
Control (C)	3.85	2.71	5.30	1.73	6.20	2.38

In Table 6, we can see that the mean pitch and interval scores were higher for C instruments compared to transposing instruments. No trend is shown in rhythm scores. Again, this data is logical because a transposing instrument affects pitch, not rhythm. This data is particularly interesting because it seems that the participants who play transposing instruments may have experienced some sort of interference effect when connecting mock fingerings with sung pitch. Since they may be used to playing transposed notes (for example, when a saxophonist fingers a written D, an F sounds), their sense of pitch may be altered by these relationships. Further research is needed in this area to explore this effect.

Table 6

Transposition Data (Music Majors Only)

Condition	Pitch		Rhythm		Interval	
	M	*SD*	*M*	*SD*	*M*	*SD*
Transposing Instruments (n=25)[a]						
Fingering (F)	3.76	2.80	5.76	2.01	5.32	2.68
Control (C)	3.60	2.58	5.60	1.72	5.80	2.56
C Instruments (n=9)[b]						
Fingering (F)	4.11	2.77	5.22	.42	5.89	3.45
Control (C)	3.89	2.73	5.78	1.87	6.00	2.40

[a]In the context of this data, transposing instruments included clarinet, French horn, saxophone, and trumpet. [b]In the context of this data, C instruments included tuba, bassoon, oboe, flute, trombone, and euphonium.

Discussion

It is important to note that while the data in this study is consistent with Frey-Clark's 2017 research on Curwen hand signs, there are multiple limitations found within the present study. First, the trends within the music major data are inconsistent: Pitch scores were greater in the F condition, but rhythm and interval scores were lower in the F condition. This is particularly confounding because the pitch and interval scores are both pitch-oriented, so it should logically follow that they would show the same trends. However, the differences in the pitch and interval trends may be due to the scoring system used. As outlined in the methodology chapter, the pitch and interval scores were designed to focus on two separate aspects of pitch-oriented success. Pitch scores were based on the correctness of the absolute pitches sung within each measure. Interval scores were based on the accuracy of the *distance* between two sung notes. If a perfect 5^{th} was written and the participant sang a perfect 5^{th}, regardless of the correctness of the absolute pitches sung, the interval was counted as correct. This distinction was to account for the differences between two potential sight singing and kinesthetic relationships. Pitch scores relied more heavily on the ability of the participant to tonicize and maintain key feeling throughout the example, while interval scores relied more heavily on the ability of the participant to sing the correct contour and intervals. However, this design may not entirely explain the lack of a clear trend, and further research would have to be done to explain this apparent discrepancy. Additionally, further research into the differences between interval skills and pitch skills could take the form of exposing separate participant groups to a series of interval exercises or a series of pitch exercises before putting those skills into context. (A study of this sort could use an approach similar to that used by Cassidy in her 1993 research on sight singing strategies.)

A second limitation is the inability to compare the scores of the music majors with the non-music majors. This is due to the separate design of the examples and the consequently separate scoring systems. If future studies wanted to examine the difference between the kinesthetic effects on music majors and non-music majors, the scoring systems used would have to be identical and the examples would have to be comparable.

A third limitation is the scoring system itself. Because the examples were scored by human graders, the likelihood of human error is high. Although the scoring system was shown to be reliable when re-scored by an outside source, this study could be improved by using pitch software for scoring purposes. In the context of this study, however, the scoring system was chosen based on the researcher's current knowledge and skill levels.

Because of these three major limitations (and others that may be unknown to the researchers at this time), it was decided that only descriptive statistics would be analyzed. Therefore, an ANOVA was not used, nor were any tests run to determine statistical significance.

As shown above, the researchers decided to further examine the data based on two potential covariates: the use of solfege, and the effects of transposing instruments. The use of solfege seemed to conclusively improve the pitch-oriented skills of pitch and interval, which is what solfege is designed to do. It did not improve the rhythm scores. Further research could focus on the use of kinesthetics alone, controlling for the use of solfege. It is important to note that the most prominent kinesthetic strategies used in sight singing, Curwen hand signs, are intrinsically related to and represent solfege syllables. Outside of this study, very little research has been done on kinesthetic pitch strategies that are distinct from the use of solfege, and further research is necessary.

The effects of transposing instruments also conclusively demonstrated that the participants who played instruments in C had higher mean pitch and interval scores. This raises the question of whether transposing instruments interfered with the use of mock fingerings, because the mock fingerings did not directly relate to the absolute pitch being sung. Further research could be done to control for the use of transposing instruments. Alternatively, more detailed research might explore whether instrumentalists who play transposing instruments experience a skewed sense of pitch due to their overwhelming experience with transposed pitches.

The data in this study is consistent with the literature, which shows that though there may be a kinesthetic connection to music performance, experimental sight reading tests have shown that other kinesthetic strategies (i.e., Curwen hand signs) are neither helpful nor hurtful (Frey-Clark, 2017). This knowledge, along with the data collected in this study, may imply that the use of kinesthetic strategies may be a matter of personal preference. This implication is furthered by participant response to the questionnaire included in this study. When asked, "Do you ever use the fingerings of your instrument to help you sing accurately?", 53.3% of participants (n=19) answered "yes," while 46.7% (n=18) answered "no." A few elaborative responses to this question include:

Yes, helps hearing intervals because I'm so used to hearing those pitches with those buttons pressed.

No, normally just rely on pitch.

Yes, it gives me a kinesthetic to relate pitches.

No, it made it harder.

Yes, it helps orient me to the pitch.

No, I find solfege hand signs more helpful. I do use fingerings in Music Theory for spelling chords and reading in my head.

Yes, often when I sing I either finger along or use solfege.

No, I typically learn aurally or with solfege signs.

These answers may lead us to consider further research on why some participants find mock fingerings useful and why others do not. It might also be interesting to examine in future studies whether participants who *believe* mock-fingerings or other kinesthetics to be useful to them actually demonstrate beneficial effects when scored on accuracy.

Implications

Although much of this present study simply raises further questions, the present findings may have implications in a music classroom. Namely, this research seems to support the idea that music educators can make use of various techniques when teaching students to sight read, and that no single technique is a perfect fit for all students. This study may encourage choral music educators to be aware of their students' other musical endeavors, namely, instrumental experience. If instrumental experience can be drawn upon to help individual students learn choral skills, it should be offered as a strategy. However, because the data does not conclusively show the positive or negative effects of kinesthetic techniques, these strategies should be offered to the students as *options* that they can use if they perceive a positive effect in their own experience.

In their research on sight singing success, Demorest and May (1995) concluded that "instruction on instruments other than piano and voice [is] only important to increased sight singing skill when taken in tandem with piano and/or voice lessons" (p. 162). If choral music educators can capitalize on the relationship between sight singing skill and instrumental instruction and draw the necessary connections to the attention of the student in question, choral music educators may be able to help their students with instrumental experience capitalize on their former musical knowledge in order to succeed in the choral classroom.

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Appendix A

Experimenter Script

1. *Start new recording. Say participant number, then pause recording.*
2. "Hello! Are you…? Perfect. Please take a seat. You are going to be asked to sing two melodies today. For each, you will be given 30 seconds of silent study time. I will not be grading you, but I am making a sound recording of our session. The only people who will ever hear these recordings will be myself and my thesis director. Are you okay with that?"
3. "What is your major?"
4. *Hand them the correct first example, face down.*
5. "The examples are written in both treble clef and bass clef. You may read whichever one you are more comfortable with."
6. "At the beginning of your 30 seconds of silent study, I will orient you to the key, finishing with your first note. Before you sing, I will play your first note for you again."

F condition:	**C condition:**
"When you sing this musical example, please finger along with the notes on the page as if you were playing your instrument."	"When you sing this musical example, please keep your hands and fingers still."

7. "You may flip over your example."
8. *Play 1-3-5-3-1-7-1. 1*
   (D-F#-A-F#-D-C#-D. D)
9. "Your study time begins now."
10. *Let study for 30 seconds.*
11. *Play 1*
    (D)
12. *Start recording*
13. "Please sing the melody (fingering along/keeping your hands still.)"
14. *Give them second example, face down. Explain condition, then repeats steps 7-13.*
15. "Would you prefer a gift card to Starbucks, Marco's Pizza, Pitas, or Pawley's?"
16. *Hand them questionnaire, with participant number and designation filled out.* "Please fill this out and place it inside the folder on the stand outside the door. Thank you."

Appendix B

Participant Questionnaire

1. Major: ________________________________

2. Primary instrument: _______________________ Years played: ______

3. Other instruments and years played:

 ____

 ____

 ____

4. Do you have formal sight singing training? (i.e., aural skills or in a choir) (Yes/No) If yes, please explain:

 ____

 ____

5. Have you ever sung in a choir? (Yes/No)

6. If yes, how many years? ______

7. Do you ever use the fingerings of your instrument to help you sing accurately?

 ____

 ____

Appendix C

Scoring Rubric

Participant Number and Designation:

M / NM

Example:

Condition:

Measure	**Pitch Point**	**Rhythm Point**
1		
2		
3		
4		
5		
6		
7		
8		
Tonality Deduction		
Flow Deduction		
Total		

Music Major		**Non-Major**	
Targeted Pitch Skill	**Point**	**Targeted Pitch Skill**	**Point**
3rds (7 pt. possible)		3rds (4 pt. possible)	
Perfect 5th (1 pt. possible)			
Perfect 4th (1 pt. possible)			
Major 6th (1 pt. possible)			
Total			