THE EFFECTS OF MUSICAL TRAINING ON SUCCESSFUL COMMUNICATION OF EMOTION

by

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Abstract

In music and speech, different combinations of tempo, intensity, and pitch can work together to express a wide variety of different emotions (Curtis & Bharucha, 2010; Juslin & Laukka, 2003). Due to the shared communicative code across these two domains, researchers have been interested in whether musical training enhances one's ability to comprehend emotion in speech. Previous research has primarily examined musicians as decoders of vocally-expressed emotion, testing their performance on tasks measuring their ability to accurately identify emotional expressions in comparison to their nonmusician counterparts. The current project tested whether musicians are better encoders of emotion than nonmusicians, examining their ability to produce vocalizations that successfully communicate the intended emotion. It also tested whether musicianship confers a decoding advantage when attempting to identify emotions in the voices of others. To test this, emotional speech samples from five musicians and four nonmusicians were recorded under carefully-controlled conditions. These recordings were then played for 8 additional participants—half musicians and half nonmusicians—who served as raters and were asked, in a four-alternative-choice task, to identify the emotion they heard in each speech sample. Results indicated no significant differences in the overall encoding success between musicians and nonmusicians. However, there was a marginally significant decoding benefit for raters who had musical training. The decoding success of raters who had musical training was 80.8%, whereas the nonmusician raters achieved 67.4% decoding success. It is unknown whether the sample size was too small to observe a similar benefit of musicianship at encoding or if the musician advantage is truly restricted to the decoding stage of communication.

The Effects of Musical Training on Successful Communication of Emotion

Emotion has provided adaptive qualities that are arguably some of the greatest contributions to the survival of the human species (Izard, 2009). The communication and recognition of emotion have paved the way for human survival in a variety of different ways. For example, being able to recognize fear or anger in others has facilitated the survival of the human race by allowing humans to distinguish and recognize threat in order to avoid it. Emotion is so deeply embedded into the human brain that humans exhibit emotions months before exhibiting the earliest linguistic behaviors (Izard, 2009). Emotional expression also plays an important part in the ability to develop relationships and bond with others (Soto & Levenson, 2009); because humans are social creatures who must work cooperatively with others to acquire food and shelter, relationships are crucial to human survival and well-being. The ability to accurately express emotion and understand the emotions of others are essential components of communication; therefore, it would be beneficial to know how successfully humans are doing so, and what factors can influence these abilities. With the recent rise of research in the field of music psychology, researchers are beginning to show interest in how musicianship affects the comprehension of emotion. Studies have shown that individuals with musical training are more able than untrained individuals to accurately distinguish emotion in not only music, but also in speech (Schellenberg & Manakarious, 2012; Thompson, Schellenberg, & Husain, 2004). The current research concerns whether musical training has an effect on the successful communication of emotion, and moreover, whether musicians will be more effective than nonmusicians in expressing emotion through speech prosody.

Musical Training and Emotion Comprehension

Emotion is manifested in many ways, such as facial expressions, body movements and posture, and vocal expressions; the ability to perceive and understand the emotions of others has been explored in numerous ways. In children, emotional comprehension is often tested through the use of narratives that describe individuals who are experiencing situations that would typically induce certain emotions--or that describe certain emotional behaviors. Emotional comprehension tests are meant to examine one's general understanding of various emotions and the causes and manifestations of emotions, not necessarily to test one's ability to accurately recognize an emotion that they observe in another individual (which is achieved through emotion recognition tests).

Many scholars have explored the factors that have been linked to individual variability in emotional comprehension, and musical training has been posited as a potential factor of influence. Schellenberg and Manakarious (2012) reported that music training in childhood is positively correlated with emotional understanding/comprehension. Participants in this study consisted of 60 seven- to eight-year-old middle school students from Toronto. Participants were instructed to complete two tests in total, one measuring emotional comprehension/understanding and an IQ test to control for potential age-related differences in intelligence. The tasks were administered in that order with a ten-minute break in between. The students completed the tests in a private room while their parents filled out a demographics questionnaire concerning their own level of education, family income, first language of both child and parent, and the child's involvement in out-of-school activities that were not music-related. Emotional comprehension was measured using the Test of Emotional Comprehension (TEC; Pons & Harris, 2000), which consists of nine different trials in which the experimenter relays a story describing a person feeling one of four different emotions that the participant can choose from. While the experimenter is delivering the story, the participant is shown a cartoon line drawing depicting the different emotions. During this test, the experimenter must make a conscious effort to avoid providing any emotional cues through facial expression or speech prosody. The IQ test used was the Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999). Schellenberg and Mankarious (2012) hypothesized that musical training would facilitate improvement in children's understanding of emotional narratives as measured by the TEC. They anticipated this result under the assumption that repeated practice of attempting to interpret emotional narratives through music during music training would benefit a child's ability to understand emotional narratives outside of a musical context, and furthermore, that developing the ability to seek out emotional narratives in music would enhance their overall emotional intelligence. The results suggested that music training was positively correlated to scores on the TEC, supporting this hypothesis and indicating a positive relationship between musical training and emotional understanding. While research supports the hypothesis that musicianship can improve an individual's ability to accurately comprehend emotion due to the repeated practice of seeking out emotional narratives in music (Schellenberg & Manakarious, 2012), there is also research to support the hypothesis that musicianship improves an individual's ability to accurately recognize emotion in speech due to the shared acoustic code that is also used in music (Curtis & Bharucha, 2010; Juslin & Laukka, 2003; Thompson, Schellenberg, & Husain, 2004). In order to understand how emotion expression is affected by musicianship, it is important to first consider how emotion is generally expressed and understood.

Musical Training and Emotion Recognition

The communication of emotion involves two stages: the encoding of the emotion by the person sending the signal and the decoding of the emotion by the person interpreting the signal. The success of the communication relies on how much the encoder and decoder make consistent use of a shared code for signaling emotion (see Brunswik for an overview of the lens model, 1956, and Scherer, 2003, for an overview of its application to the communication of emotion). The majority of the research relating to the influence of musicianship on the communication of emotion has focused on success at the decoding stage, examining whether musicians are better than nonmusicians at identifying the emotions they hear in the voices of others.

Thompson, Schellenberg, and Husain (2004) were the first to demonstrate a causal relationship between musical training and the ability to accurately decode vocal expressions of emotion. Their research suggested that this advantage may stem from a facilitated ability to interpret tone sequences. In the first of three experiments, 20 undergraduate psychology students were asked to listen to tone sequences played in a flute timbre that were meant to simulate the temporal structures of spoken phrases and identify the corresponding emotion. Participants consisted of musicians and nonmusicians. The results indicated that musicians were more accurate at identifying emotions from the tone sequences than nonmusician participants. In the second experiment, the researchers sought to identify whether the positive correlation found in the first experiment could have simply been attributable to a musician advantage for recognizing the emotions of tone sequences, which can be considered a music perception task. The researchers were interested in whether the results would remain consistent if the participants were given a speech prosody task in addition to the task consisting of tone sequences. The participants were 56 adults, including undergraduate psychology students and members of the music faculty. To measure accuracy of decoding emotion through speech prosody, participants heard 40 trials of speech samples in total, half in English and half in a foreign language (Tagalog) that was not spoken by any of the participants. The participants in this second experiment also completed the same task as those in the first experiment--identifying the emotion of tone sequences played in a flute timbre. Results of this experiment were consistent with the first; musician participants performed, on average, more accurately than non musician participants in detecting the predetermined emotions the stimuli were meant to convey. This second experiment also found that musician participants were more accurate than nonmusicians at identifying stimuli depicting sadness and fear. While these two previous studies presented strong correlational evidence to support a musician advantage in emotion comprehension, a third experimental study conducted with child participants demonstrated a causal relationship.

To test whether musical training may be the cause of the emotion recognition advantage for musicians observed in the first two studies, Thompson et al. (2004) conducted a controlled experiment directly testing the influence of music lessons on children's emotional recognition abilities. This experiment consisted of 43 seven-year-olds who were randomly assigned a year of either keyboard, singing, or drama lessons. Children in a control group were not assigned any lessons until after the experiment had already been conducted. Following the year of assigned lessons, participants were tested on their ability to accurately recognize emotion through speech prosody in their native language (English) and a foregin tonal language (Tagalog). They were also asked to complete the emotional tone sequence task used in the first two studies. Results indicated that children assigned to music lessons performed better on the emotional decoding tasks than children who were not assigned any lessons, as well as better than the children who were assigned to drama lessons. This third experiment only further reinforces the conclusions of the two that preceded it, suggesting that the positive correlation between music training and emotional comprehension observed in these studies may be reflective of a causal relationship. These results are also consistent with the theory that the neural functions and tools used to comprehend emotion could possibly be the same functions people use to understand the emotions communicated by music (Juslin & Laukka, 2003). It also implies improvement of these functions through musical training.

In a direct challenge to the findings of Thompson et al.'s (2004) study, Trimmer and Cuddy (2008) published a study suggesting that emotional intelligence may play a more important role than musical training in the decoding of vocally-expressed emotions. Trimmer and Cuddy recruited 100 native-English-speaking undergraduate students with the primary objective of testing whether musical training was positively associated with greater sensitivity to emotional prosody in speech and whether this association was greater than that of emotional intelligence. Participants completed two emotional recognition tasks, one in which they were presented with pre-recorded spoken phrases and one that consisted of gliding tone analogs, which contained the synthesized pitch contours of speech samples but no semantic or articulatory content. For each task, participants had to rate the presence of an emotion on a scale from 1 (the emotion is not present at all) to 10 (the emotion is particularly prominent in the stimulus). It is worth noting that this measurement approach differs from the forced-alternative-choice method used in the other studies described above, as it may explain the inconsistent findings between studies. Results of this study indicated musical training was not a significant predictor of performance on the speech prosody or tone analog tasks. The researchers did, however, find that emotional intelligence was a significant predictor of accuracy on both tasks. This study challenges results of pre-existing literature by suggesting emotional intelligence is more crucial in comprehending emotion through speech prosody as opposed to musical training. However, there were various methodological differences between this experiment and the three prior studies (Thompson et al., 2004), including stimulus types, perceptual tasks, method of measuring emotional recognition, and method of measuring musicianship. Any one of these methodological differences could have resulted in the inconsistent results observed across publications.

A musicianship advantage, as reported by Thompson et al., (2004), has been replicated by subsequent researchers. Lima and Castro (2011) examined the relationship between musical training and the ability to decode emotion through speech prosody. The primary question of this study was whether musicians were able to more accurately recognize emotions through speech prosody than those of their nonmusician counterparts. Participants were administered preliminary tasks and surveys to measure demographics and cognitive functioning. They were then asked to identify the emotions communicated by speech samples that contained affectively-neutral semantic content in order to put the emphasis and participants' focus on emotion expression and prosody. Seven different emotions were examined. The variables measured in this experiment included each decoder's level of musical training, age, response time, cognition, and education. Results suggested that musicians were able to more accurately decode which emotions were being conveyed in the speech samples. However, nonmusicians performed significantly better than musicians when identifying happy stimuli. The researchers concluded this to be a result of bias amongst the non musical participants to choose happy as a response to all stimuli; therefore, these results do not indicate that nonmusicians were more sensitive than musicians to the cues in happy vocalizations. What these results do indicate, however, is that musical training appears to be related to an individual's ability to comprehend emotional expression through speech prosody.

Juslin and Laukka’s (2003) meta-analysis on emotional expression in both speech and musical performance provides a convincing argument for the relationship between these two modes of communicating emotion. Using 104 studies of the expression of emotion through speech and 41 studies of the expression of emotion through music to build a thorough review of how emotion is expressed in both domains, Juslin and Laukka provided a solid basis for understanding how people successfully communicate emotion through these two modes, as well as evidence to suggest largely parallel use of acoustic cues in each modality for communicating the same emotions. In this empirical review, Juslin and Laukka draw upon the lens of evolutionary psychology (e.g., Buss, 1995) to explain the musical communication of emotion, proposing that, functionally, the brain perceives any acoustic expression of emotion--regardless of whether it comes in a musical or linguistic form--as an expression of important information that may have relevance for one’s survival or the maintenance of social bonds. Juslin and Laukka suggested that there is ample evidence to support the theory that the communication of emotion through music is due largely to the similarity it holds to the human voice. For example, certain timbres such as the violin or sliding guitar could be heard as closely resembling human vocal expressions/prosody--and certain functional modules of the brain may treat these sounds as if there is no meaningful distinction between speech and music. The theory that music’s ability to evoke emotion stems from its acoustic similarity to vocal expressions of emotion was posited by

Darwin and has, in recent decades, attracted increasing interest in the research community as the evidence for a shared acoustic code has mounted in parallel with the evidence for shared neural overlap for the processing of many properties of speech and music.

Juslin and Laukka (2003) noted an important finding concerning the universality of these emotional signals. Participants were consistently accurate at identifying emotion both within their own culture and cross-culturally; this was true of their understanding of emotion in speech as well as in music. This suggests not only that speech is a successful vehicle of emotional expression within and across cultures, but that music is as well. The overlapping set of acoustic cues for communicating emotion in speech and music (noted by Juslin & Laukka, 2003, and more recently demonstrated by Curtis & Bharucha, 2010), if used with some consistency across cultures, would enable the type of cross-cultural recognition of emotion that has been noted when listening to music that is culturally unfamiliar (as reviewed by Juslin & Laukka, and more recently, as demonstrated by Fritz et al., 2009). More generally, it also underscores the hypothesis that knowledge of how emotion is communicated in music can facilitate emotional understanding in speech.

The current study investigated the two stages of emotional communication--encoding and decoding--to examine whether there is a musicianship advantage at either stage of communication. To achieve this, recordings of emotional speech samples were collected from musicians and nonmusicians under controlled conditions. These recordings were then played for a different set of participants, musicians and nonmusicians, who attempted to accurately identify the emotion of the speaker in an alternative-forced-choice task. The experiment was designed to test the hypothesis that musicians will have superior encoding and decoding than nonmusicians.

Methods

Participants

Two sets of participants were recruited for this experiment: actors and raters. All were recruited from the Purchase College community. Nine participants served as actors in this study. Five were musicians and four were nonmusicians; one from each group was male and the rest were female. Although we did collect further demographic information, it is locked in a lab that we are currently unable to access due to the COVID-19 pandemic.

Eight participants served as raters. Their mean age was 21.86 years (*SD* = 8.47). Four played musical instruments and four did not. Those with musical training had been playing their instruments an average of 14.25 years (*SD* = 14.17). Seven of the participants were female; the one male was a nonmusician. The raters were recruited from the Psychology Participant Pool and were compensated with course credit for participation.

Materials

Participant actors were asked to record spoken stimuli demonstrating four different emotions, anger, happiness, neutral/pleasantness, and sadness, from scripts provided by the experimenter (obtained from Curtis & Bharucha, 2010; see Appendix A). The scripts consisted of an emotional context--a short narrative description of a situation that would typically elicit one of the four specified emotions, followed by a target phrase that each participant was to recite, attempting to communicate the specified emotion. Each target phrase was an affectively-neutral two-syllable phrase that the participant would say out loud. The scripts contained three different target phrases that were repeated in each of the four emotional states (in response to different emotional contexts specified in the scripts), so the semantic content was held constant across emotions in order to put emphasis on the nonverbal emotional communication and acoustic cues. The target phrases included "Okay," "Let's go," and "Come here." The recordings of the target phrases were made on an iPhone, provided by the experimenter, using the voice memo app to record each individual vocalization.

The vocalizations recorded by the participant actors were used as the stimuli for the raters in the second phase of the experiment. The stimuli included 26 angry, 27 happy, 27 pleasant/neutral, and 27 sad vocalizations.

The following demographic information was collected about each participant: age, race, first and second language (if any), gender identity, place of birth, and current place of residency. The demographics questionnaire is contained in Appendix B.

We also used an assessment of musical training for each participant (see Appendix C). This will enable us to assess whether musical training is associated with greater communicative success.

Procedure

Each participant was tested individually. After completing the informed consent process, each participant who was serving as an actor was escorted into a sound-attenuated chamber, where the task was explained and they were provided with scripts and an iPhone into which to make their recordings. They were instructed to read through each emotional narrative and do their best to say the target phrase with the intended emotion. Each participant was able to record their vocalizations in isolation so that they would feel more comfortable with the situation (because no one will hear them). The use of the iPhone enabled the participants to easily delete recordings that they did not want anyone to hear.

Each participant's recordings were imported onto a computer after each participant had been tested, and their recordings were removed from the iPhone at that time (so the next participant would not have access to them). The recordings were edited with Audacity so as to isolate each target phrase into one sound file. These recordings were then used as stimuli in the second phase of the study.

To test the communicative success of the participant actors, additional participants were recruited online to serve as raters. After completing the informed consent process, each rater was presented, via Qualtrics, with one stimulus file at a time, a vocalization produced in the first phase of the study, and was asked to choose which emotion (happy, sad, pleasant/neutral, or angry) the participant was attempting to communicate. Pleasant/neutral was operationalized as the tone that a speaker might take when trying to politely make small talk. The raters completed 107 trials that were equally distributed (roughly) across four blocks.

Results

Effect of Musicianship on Communicating Emotion

A repeated-measures ANOVA with one repeated measure (intended emotion: anger, happiness, neutral/pleasantness, or sadness) and one between-subjects measure (musician/nonmusician) was used to determine whether the acting participants with musical training were more successful at vocally communicating emotion than the participants without musical training. The acting participants were treated as the subjects for this analysis. Each acting participant's overall communicative success for each emotion served as the dependent variable and consisted of the percentage of raters who correctly identified the actor's target emotion.

Mean accuracy rates for each condition are displayed in Table 1. There was no effect of musicianship on communicative success, $F(1,7) = 0.11$, $p = 0.749$; musicians displayed 75.8% accuracy and nonmusicians displayed 73.8% accuracy. Communicative success did, however, differ significantly between emotions, $F(3,21) = 3.54$, $p = 0.032$; anger was communicated more successfully (90.6%) than happiness (67.8%), neutral/pleasantness (67.3%), and sadness (73.6%).

The overall communicative success for specific emotions did not interact with musicianship, $F(3,21) = 0.56$, $p = 0.650$. However, exploratory analysis of the incorrect responses revealed that musicians and nonmusicians exhibited different types of challenges when communicating specific emotions. A confusion matrix is shown in Table 2. The primary differences relate to the ability to communicate happiness and neutral pleasantness. Musicians exhibited 76% success when attempting to communicate happiness, compared to 57% success for nonmusicians. The confusion matrix indicates that nonmusicians tended to undersell their happiness, as the raters guessed that 31% of the happy samples produced by nonmusicians were actually neutral/pleasant (compared to making that mistake for only 13% of the happy samples produced by musicians). The likelihood of happy vocalizations being mistaken for angry or sad vocalizations was roughly equal for musicians and nonmusicians. When attempting to communicate neutral pleasantness, an emotion that was described to participants as the tone one would use when making polite small talk, musicians tended to overshoot the positivity of the emotion; 24% of their neutral/pleasant vocalizations were mistaken for happy vocalizations, compared to only 12% of the neutral/pleasant vocalizations produced by nonmusicians. The nonmusicians, however, were far more likely than the musicians to be interpreted as angry when trying to communicate neutral pleasantness; 17% of their neutral/pleasant vocalizations were mistaken for angry vocalizations, compared to only 2% for musicians.

Effect of Musicianship on Identifying Emotion in Speech

Half of the raters were musicians, and half were nonmusicians, enabling a post-hoc analysis of rater musicianship as a subject variable that might explain variability in the raters' levels of success at accurately decoding the intended emotion.

A repeated-measures ANOVA with one repeated measure (intended emotion: anger, happiness, neutral/pleasantness, or sadness) and one between-subjects measure (musician/nonmusician) was used to determine whether the raters with musical training were more successful at successfully decoding the intended emotion of each speech sample than raters who were nonmusicians. The raters were treated as the subjects for this analysis. Each rater's overall decoding success for each emotion served as the dependent variable; specifically, this corresponded to the percentage of samples correctly identified by the rater for that emotion. (Missed trials--stimuli for which no responses were entered--were counted as incorrect.)

Mean accuracy rates for each condition are displayed in Table 3. The effect of musicianship on decoding success was borderline significant, $F(1,6) = 4.66$, $p = 0.074$, $\text{np}^2 = 0.437$; musicians displayed 80.8% accuracy when labeling emotions, and nonmusicians displayed 67.4% accuracy. Decoding success differed significantly between emotions, $F(3,18) = 8.62$, $p < 0.001$; anger was communicated more successfully (88.9%) than happiness (67.1%), neutral/pleasantness (67.1%), and sadness (73.1%). There was no interaction between emotion and musicianship, $F(3,18) = 0.16$, $p = 0.921$.

Discussion

This research sought to examine whether musical training enhances an individual's ability to successfully communicate emotion. Based on past research indicating musicians performed better on tasks measuring emotional comprehension (Schellenberg & Manakarious, 2012; Thompson et al., 2004), it was hypothesized that musicians would also have an advantage in emotional expression than their nonmusician counterparts. While there was no main effect of musicianship on overall successful communication of emotion, musicians were more accurate in communicating happiness than nonmusicians. In all emotion samples, anger was communicated most successfully, followed by happiness, neutral/pleasantness, and sadness .

Additionally, when musician samples that were meant to portray neutral/pleasantness were decoded incorrectly, they were more likely to be mistaken for happiness than other emotions, which is not a costly mistake in the context of a polite interaction. However, when nonmusician failed to successfully communicate a neutral or pleasant demeanor, their attempt at pleasantness tended to be mistaken for anger. This finding suggests that musicians were more likely to over-sell an expression of pleasantness or politeness with a level of arousal higher than it would normally be during this kind of expression. However, these expressions were more akin to happiness, an emotion more closely linked to neutral/pleasantness in terms of valence and audial signaling. Whereas incorrectly decoded non musician neutral/pleasantness samples were 8.5 times more likely to be interpreted as angry than those of the musicians. It is possible that musicians being more likely to express happiness when trying to convey pleasantness may be linked to their advantage in emotional comprehension. Furthermore, because musicians are more familiar with the audial similarities between pleasantness and happiness due to repeated practice interpreting these audial cues in music which are the same cues used in speech, they could be more likely to produce an expression that holds the same audial cues even when failing to present the correct level of arousal.

This suggests that musicians might have an advantage in their ability to avoid making alarming emotional signaling errors, such as accidentally expressing anger when trying to convey politeness.

When looking at the effect of musicianship on decoding ability, raters with musical training had a slight advantage with 80.8% accuracy, whereas nonmusicians displayed a 67.4% accuracy. While this finding was on the borderline of statistical significance, it is important to note that it trends in the direction of supporting previous research that shows a musician decoding advantage. It is unknown whether the sample size of this study restricted its ability to replicate those previous findings, showing a clear positive correlation between musical training and successful emotion comprehension. However, based on previous research that has consistently shown an advantage in musician ability to perform better on tasks measuring emotional comprehension, it would be reasonable to hypothesize another study with a similar sample size would repeat those findings.

It is also unclear as to whether the sample size of this study restricted the ability to observe for a main effect of musicianship on an individual's ability to successfully communicate emotion or if the advantage is strictly limited to the comprehension of emotion.

Limitations

The main limitation to this study was that it had to be completed in one year. If there had been more allotted time, more participants would have been recruited, and thus, a larger dataset which may have yielded different results that would have been more generalizable. Additionally, online collection of the decoding data introduced uncontrolled factors. These participants were originally going to be recruited in person; however, due to COVID-19 precautions, the decoding task was completed remotely in an uncontrolled environment, and the study did not account for possible environmental distractions.

Future Research

Future research should more closely examine the role musical training has on an individual's ability to successfully communicate emotion through speech by collecting a larger sample size and larger emotion sample database that is a more accurate representation of the larger population. It would be interesting to decipher whether musical training plays any role in the successful communication of emotion or if it only yields benefits strictly for comprehending/decoding vocally expressed emotion.

While future research should further analyze the success rate of musicians' emotional expression, it would also be interesting to further examine the kinds of disparities between incorrectly decoded musician and nonmusician emotion samples. It was observed in the present study that expressions of pleasantness were more likely to be confused for happiness when expressed by a musician as opposed to nonmusician pleasantness samples, which were more likely to be mistaken for anger. Future research should examine the possibility that incorrectly interpreted musician emotion samples are more likely to be mistaken for emotions that are more similar in quality, in terms of the experience of the emotion, as opposed to nonmusician samples, which may be more likely to be mistaken for less similar emotions, leading to greater levels of miscommunication in social situations.

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Table 1. *The Communicative Success of Musicians and Nonmusicians Attempting to Convey Four Emotions Through Speech Cues*

	Musician Actors	Nonmusician Actors	Mean for Each Emotion
Anger	90.4% (11.4)	90.6% (8.6)	90.6%
Happiness	75.0% (13.8)	60.4% (26.5)	67.8%
Neutral Pleasantness	66.7% (24.8)	67.7% (9.2)	67.3%
Sadness	70.8% (19.5)	76.0% (15.7)	73.6%
Group Mean	75.8%	73.8%	-

Note. The success rate indicates the percent of raters who were able to correctly identify the intended emotion.

Table 2. *Confusion Matrix for Identifying the Intended Emotion, According to Musical Training of the Speakers*

Intended Emotion of Vocalization	Musical Training of Speaker	"Angry" Responses	"Happy" Responses	"Neutral/ Pleasant" Responses	"Sad" Responses
Anger	Musicians	89%	2%	4%	4%
	Nonmusicians	91%	1%	3%	5%
Happiness	Musicians	7%	76%	13%	3%
	Nonmusicians	9%	57%	31%	3%
Neutral/Pleasant	Musicians	2%	24%	67%	7%
	Nonmusicians	17%	12%	68%	3%
Sadness	Musicians	8%	2%	20%	69%
	Nonmusicians	6%	3%	15%	76%

Note. Musicians were more able to accurately communicate happiness than nonmusicians; nonmusicians tended to communicate neutral/pleasantness when they failed to successfully communicate happiness, suggesting that they achieved the right valence but wrong level of arousal. When making failed attempts to communicate neutral pleasantness, musicians tended to overshoot the intensity and communicate happiness, whereas nonmusicians tended to mistakenly communicate anger (and were 8.5 times more likely to do so than the musicians). These differences in the confusion matrix indicate that the musicians in this study were less likely than the nonmusicians to make the types of signalling errors that would cause alarms--such as communicating anger when one is trying to sound polite.

Table 3. *The Decoding Success of Musicians and Nonmusicians*

	Musician Raters	Nonmusician Raters	Mean for Each Emotion
Anger	96.2% (3.1)	81.7% (14.5)	88.9%
Happiness	74.1% (5.2)	60.2% (16.7)	67.1%
Neutral Pleasantness	75.0% (9.3)	59.3% (19.4)	67.1%
Sadness	77.8% (9.1)	68.5% (11.5)	73.1%
Group Mean	80.8%	67.4%	-

Note. The success rate indicates the percent of speech samples that were accurately identified for the intended emotion in a 4-alternative-forced-choice task. Musicians were marginally more accurate than nonmusicians for all emotions.

Appendix A

PLEASANT- you are about to go out for ice cream with your friend, but you can't find your wallet. Your friend tells you not to worry, that she'll treat you. Since she usually borrows money from you and never pays you back you're very quick to happily say, "Let's go."

PLEASANT- you want to give your nephew a cookie because he's so adorable. And because his mother wouldn't let him have one earlier and you know it's a good way to get on his good side, so you say, "Come here."

PLEASANT- Your friend asks you if you want to go to the store with him. The person who works at the store is really cute and you think you look hot today, so you say, "Okay."

ANGRY- You're in a bar with a friend and you want to leave and go to a party where other friends are waiting for you. But your friend at the bar doesn't want to leave because he's hitting on a girl who's totally not interested. And he doesn't want you to leave without him. You keep telling him you want to leave, and he keeps telling you to wait another minute. Finally, getting angry, you yell, "Let's go!"

ANGRY- You've just found out that your little nephew has fingerpainted your wall, even though you explicitly told him to keep the paint on the paper. He tells you that Andrew his older brother who should know better, told him to do it. You are very angry at Andrew and need to yell at him. He's hiding, but the next time you spot him you yell "Come Here!"

ANGRY- You're in the middle of a fight with your significant other and s/he keeps reiterating the same thing over and over. You got the point a long time ago, but s/he won't stop! Frustrated and angry you yell, "Okay!"

VERY HAPPY- Your best friend asks you if you want to go to the Red Sox game with him. You love the Red Sox! And best of all, he's paying for your ticket! You excitedly say, "Okay!"

VERY HAPPY- You just heard that the first 10 people to get to the local radio station will get free tickets to the sold out Kendrick Lamar concert. You love Kendrick Lamar! You grab your best friend and excitedly say, "Let's go!"

VERY HAPPY- Your adorable three-year old nephew has just arrived for a visit. You haven't seen him in a couple months and are so excited to see him. You want to give him a big huge hug, so you throw your arms open and say, "Come here!"

SAD- Your cat just dies. A friend asks you how you're doing, and you sadly say, "Okay", even though you're not

SAD- Your best friend has just told you that her mother is ill. You're both very sad and want to give her a hug, so you say, "Come here."

SAD- You and your sister are about to drive to the vet to put your beloved dog to sleep because he's terminally ill and miserable. Neither of you want to do it, but you can't bear looking into your dog's rheumy eyes anymore. Finally you make the final push and say sadly, "Lets go."

Appendix B

1. How old are you? ___
2. Please specify your ethnic background
    - White
    - Hispanic or Latino
    - Black or African American
    - Native American or American Indian
    - Asian / Pacific Islander
    - Other Please Specify _____
3. Gender Identity : _______
4. Country of birth: _____
5. Current state of residency: ______

Appendix C

Do you play any musical instruments?

Yes No

If yes, how many years have been playing the instrument that you have played for the longest amount of time?

____

Do you have formal musical training (i.e., music lessons)?

Yes No

If yes, how many years of training do you have on the instrument that you have the most training on?

____

Do you have any hearing deficits that you know of?

Yes No

If yes, please explain.

____

____

____

Do you have any acting experience?

Yes No

If yes, how many years have been engaged in acting?

____

Do you have any formal acting training (such as classes, working with a teacher/coach)?

Yes No

If yes, how many years of acting training do you have?

____