THE PENNSYLVANIA STATE UNIVERSITY
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DEPARTMENT OF PSYCHOLOGY

READING THE MIND IN THE MUSIC: LINKING AUDITORY AND VISUAL EXPRESSIONS OF EMOTION

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ABSTRACT

How can we label the rich emotions that music communicates? Predictably, much of the music and emotion literature thus far has focused on verbal labeling of musical excerpts (for example, "sad" and "happy"). However, verbal labels may not sufficiently capture the strength or complexity of music's emotion. Facial expression, another modality of emotion expression, should be considered when describing music. The present study seeks to explore the relationship between musical, verbal, and facial expressions of emotion. In this study, undergraduate student listeners were asked to listen to three short musical excerpts, six times each. For each listening episode, participants were presented with either two emotional words or two emotional eye images. They were asked to decide which word or image best matched the emotion that the music communicated. Results indicated that facial expression labels were a viable alternative to verbal labels in simple emotional communication in music. Future studies should investigate the use of facial expression labels in complex musical emotions, as well as the effect of visual stimuli on individuals' interpretations of music.

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Chapter 1

Introduction

The thoughts which are expressed to me by music that I love are not too indefinite to be put into words, but on the contrary, too definite.

Felix Mendelssohn, composer

Recognition of emotions in instrumental music has been shown to be remarkably consistent across individuals. Vieillard and collaborators (2008) demonstrated this convincingly when they developed happy, sad, scary, and peaceful musical excerpts (based on the Western tonal system) that were easily categorized by non-musicians. Musical emotions can not only be recognized reliably; they can also be identified quickly, in as little as 250 ms (Peretz, Gagnon, & Bouchard, 1998) or after hearing as few as 3-5 musical events (Vieillard et al., 2008).

The ability to differentiate between simple "happy" music and "sad" music develops early in life. In one study, 3- and 4-year-olds distinguished between happy and sad music based on tempo differences, and 6- to 8-year-olds discriminated based on both tempo and mode (Dalla Bella, Peretz, Rousseau, & Gosselin, 2001). There is even suggestive evidence that the ability to make the discrimination between happy and sad music is possible as early as 9 months of age (Flom, Gentile, & Pick, 2008). The early emergence of this skill as well as similarities between musicians' and non-musicians' judgments (Bigand et al., 2005) suggest that these identifications are not the result of formal training.

It is remarkable that music can consistently convey or induce mental states through auditory signals. When we consider the high concentration of auditory cues that we encounter for

emotional expression in the world, perhaps these consistencies are not so surprising. Much of the emotional content in our speech is expressed in aspects that music shares. Juslin and Laukka (2003) reviewed 145 studies of either musical or vocal expression. They determined that there are indeed cross-modal parallels in emotional expressions in speech and in music (such as rate of speech/tempo, voice quality/timbre, and pitch). This link was echoed by Patel and Daniele (2003), who showed that the rhythmic differences between typical French instrumental music and typical English instrumental music parallel the rhythmic differences between spoken French and spoken English. However, music contains other elements, such as major and minor modes and time signatures, which do not have direct analogues in speech prosody though they are clearly important in emotional identification (Dalla Bella et al., 2001; Flom et al., 2008).

Though literature on musical emotion has been growing, many questions remain. One enduring problem in the music psychology literature is how best to label emotions. Are verbal labels adequate? Though this is a question often asked, it is rarely addressed methodologically. A number of researchers *have* attempted to avoid this problem. Some have retained linguistic responses, but they have asked respondents to rate excerpts on several emotion scales rather than categorize emotions (Dalla Bella et al., 2001). Bigand et al. (2005) asked participants to group excerpts based on their similarities, and found that the groupings occurred consistently across several dimensions. Dalla Bella et al. (2001) used happy and sad drawn faces to test whether children could correctly identify musical emotion.

That so many different strategies are being employed in this field illustrates the overarching concern (shared by Mendelssohn at the start of this chapter) that words may not be adequate labels for the emotions imparted by music. Other modalities of emotional expression have been explored, but perhaps none so thoroughly as facial expression. Research participants show very strong agreement when identifying simple and complex mental states based on facial expressions (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Baron-Cohen et al., 2001).

Interestingly, for complex emotions such as interest or hostility, images of only the eyes have been found to be as informative as the entire face (Baron-Cohen et al., 1997). Baron-Cohen et al. (1997, 2001) linked the correct reading of these mental states with the capacity for "theory of mind": the ability to ascribe mental states to others, as well as the understanding that others' mental states may differ from one's own.

To my knowledge, no one has yet attempted to determine whether facial expressions such as those used by Baron-Cohen would be appropriate for labeling musical emotion. There are several motivations for exploring this alternative mode of expression and its relation to music. First, it is possible that ascribing mental states to music is also related to theory of mind. If this is the case, it may be that the link between affective eyes and music is more direct than that of words and music. One goal of the present study is to investigate the link between music and affective eye images.

This strategy, if viable, might also be used to shed light on the issue of complex musical emotions. A current challenge in this field is to determine what musical structures underlie emotive passages. In Bigand et al.'s (2005) multidimensional study, researchers concluded that valence (positivity or negativity) and activation (high tension or low tension) were continuous for musical emotion judgments, suggesting that mixed or complex emotions are possible in music. It would be desirable to determine what emotions the intermediate valences represent to better understand the structural components of the music critical for emotive communication.

From an evolutionary perspective, the high agreement shown in face and eye expressions is not surprising. The ability to accurately interpret the mental state of another individual, and thereby infer their intentions could clearly confer an evolutionary advantage. Auditory cues could be informative, as well, particularly in speech. The ability to accurately interpret emotionally charged auditory cues might be as important as interpreting visual cues. It is possible, in fact, that

agreement for musical emotions might be as high or even higher than agreement for eye expressions. The present study explores this hypothesis.

Chapter 2

Methods

The musical excerpts used in the study were created and validated by Vieillard et al. (2008) specifically for music emotion research. The present study seeks to examine the relations between expressive eye images, expressive words, and music emotion.

Participants

Twelve undergraduates were recruited to participate without regard to musical training (3 men and 9 women, $M = 20.33$ years), though three of the twelve indicated they had had formal musical training in the past, ranging from 3 years to 8 years. No participants reported any hearing problems, and all participants had either normal (or corrected-to-normal) vision. Subjects received credit towards introductory psychology courses for their participation.

Apparatus and Stimuli

Three contrasting emotional musical excerpts were selected from Vieillard et al.'s (2008) excerpts: happy (*g08*), sad (*t14*), and threatening (*p07*). The musical clips had been validated for these emotions in previous research. Emotive eye images from Baron-Cohen et al. (1997) that most closely corresponded with the excerpts' emotions were selected (see Appendix A). The *happy* excerpt was paired with the *happy* eye image. A *sad* image was not available from Baron-Cohen's 1997 paper. *Distressed* was the most closely related and was used as a substitute for *sad* in the present study.

The cross-modal representations for *threatening* presented a challenge, since *threatening* is not considered to be a "simple" emotion. To represent the *threatening* excerpt, the simple emotion word *angry* was selected, and the eye image representing *disgust* was selected (neither *angry* nor *threatening* were available from Baron-Cohen's 1997 paper). Reponses to the stimuli were collected in survey form, using Qualtrics Survey Software.

Procedure

Participants were tested individually in a quiet room. Participants were seated at a computer and listened to excerpts through headphones. They were invited to adjust the volume to a comfortable setting throughout the experiment as desired.

The survey contained two blocks of trials. In the first block, each of the three excerpts (10-15 seconds per excerpt) was played six times, for a total of eighteen plays. Each time an excerpt was played, either two emotive eye images or two emotional words (selected from *happy, sad,* or *angry*) were displayed (see Appendix B for examples). The position of the responses (top or bottom) was randomized for each trial for each participant to control for position effects. Participants were instructed to select the word or image that best matched the emotion of the clip.

The second block contained nine trials. In each trial, participants saw one emotive eye image (selected from the three used in the first block of trials), and two emotive words (also from the first block) (see Appendix B). In the second block, participants were asked to choose the word that best matched the emotion of the eyes.

Both blocks contained forced-choice trials, so even if participants did not think either choice was correct, they were still required to select one to continue with the survey. Trials were presented in random order within each block.

Chapter 3

Results

In the present study, there were three types of trials: musical excerpts with word choices ("MW"), musical excerpts with eye choices ("ME"), and eye images with word choices ("EW"). Critical trials (trials in which the target was present) were explored first. Out of 27 total trials, 18 were critical trials. Table 1 presents the number of correct responses for the critical trials in each type.

Table 1
Number of participants selecting the target (N=12)

Stimuli	*Trial Type*			*Total Errors*
	MW	*ME*	*EW*	
Happy/Sad*	12	12	11	1
Sad/Happy*	12	12	12	0
Sad/Angry*	12	10	12	2
Angry/Sad*	11	5	9	11
Angry/Happy*	12	10	11	3
Happy/Angry*	12	10	10	4
M	11.80	9.80	10.83	
SD	0.41	2.56	1.17	

*Indicates the target for each trial. MW represents musical excerpts paired with words, ME represents musical excerpts with eye images, and EW represents eye images with words.

Participants showed strong agreement on all trials, but the strongest agreement occurred in MW trials, totaling only one error overall. However, participant performance was also strong for ME and EW trials, most achieving 10, 11, or 12 out of 12 agreement.

Across trial types, the lowest agreement occurred in *Angry*/Sad* trials. The weakest agreement of all trials was *Angry*/Sad* in the ME trial type, where only 5 of 12 participants selected the target response.

Non-critical trials were examined next. In these trials, the target response was not one of the possible responses (for example, trials where the stimulus was "Happy" and the responses *sad* and *angry* were given). Table 2 shows the number of participants selecting each response for the stimuli given (either music or eye images).

Table 2

Number of participants selecting each response (N=12)

Stimuli	*Responses*	*Trial Type*		
		MW	*ME*	*EW*
Happy	Angry	2	7	5
	Sad	10	5	7
Sad	Happy	1	2	7
	Angry	11	10	5
Angry	Sad	11	10	11
	Happy	1	2	1

As expected, for the "Happy" stimulus, *angry* and *sad* were chosen with close to chance probability (6/12) for the ME and EW trial types. Unexpectedly, this did not hold for the MW trials, where participants were significantly more likely to select *sad* than *angry* in response to the *happy* stimulus. Across all trial types, for the "Angry" stimulus, *sad* was selected far more often than *happy*. For the "Sad" music, *angry* was selected far more often than *happy* when participants were given the musical stimuli. Unexpectedly, in EW trials, only 5 of the 12 participants selected *angry*.

Chapter 4

Discussion

The goal of this experiment was to elucidate the links between musical excerpts, verbal labels, and emotive eye images. Twelve participants were asked to listen to emotive musical excerpts and select the word or eye image that best matched the emotion, as well as view eye images and select the word that best matched its emotion. In general, participants showed very high agreement across trial types, and in some cases, as much as they possibly could (a ceiling effect).

Extremely high agreement for musical excerpts in MW trials independently verifies Vieillard et al.'s (2008) "excerpts for research in music emotion" for the three excerpts used here (*g08*, *t14*, and *p07*). This supports the growing body of work showing that musical emotions are consistently interpreted across individuals. In fact, MW trials conferred almost 100% agreement across all trials.

Agreement in ME trials was also very strong. Participants used linguistic labels and eye images to identify musical emotions with approximately equal success in this survey. If there is a difference between linguistic labels and eye images for musical emotions, this test was not sensitive to that difference. A more difficult version of this task, perhaps employing three or four choices rather than two, might be able to show more subtleties in these relations. Additionally, future versions of this test could employ multiple happy, sad, and angry musical clips from Vieillard et al.'s excerpts, and/or could repeat the same trials multiple times throughout the experiment to determine whether responses are consistent within participants.

The EW trial type also had very high agreement for the simple emotions given. Again, if there is a difference between MW and EW trials, the present data did not reveal it. A larger sample size combined with a more demanding task might reveal differences if they exist. The hypothesis that musical emotions would confer agreement higher than eye images remains.

Of all the critical trials, the most notable ones were *Angry*/Sad* pairs. Here, participants heard the "angry" musical excerpt and could choose between *angry* and *sad* eye images. Only 5 of the 12 participants selected the target.

How can we explain this outcome? We might first conclude that the music was uninformative. However, for the MW version of this trial, 11 of the 12 participants selected the target, so this conclusion is unlikely. It is also possible that the eye images were uninformative. However, the *angry* and *sad* eye images were readily identified in EW trials, so this also is unlikely to be correct.

A possible explanation illustrates a challenge in music cognition research: the unclear distinction between recognized and induced emotions. In the first case – recognized emotions – musical emotion may be recognized by listeners but not necessarily felt; for example, you may be able to recognize a piece as joyful or triumphant without feeling those emotions yourself. In the second case – induced emotions – emotion is created in the listener; for example, hearing a woeful piece of music makes one feel depressed.

It is yet unclear whether these two approaches are drastically different in terms of participants' responses. In the present study, participant instructions – to match *the emotion the music is communicating* – most closely match the "recognition" approach. However, it may be that the strength of the *sad* eye image very closely matched an induced feeling of distress, leading participants to select the induced emotion more often for this trial than for the paired verbal label counterpart. In the future it would be beneficial to test multiple excerpts from the same emotional

category to determine whether this result is unique to this excerpt or occurs across *angry* musical excerpts.

Another possible explanation is one that has not yet been explored in music cognition. This study's methodology (and all other previous studies in musical emotion, to my knowledge) assumes that participants interpret the emotional expression of the music and then select the best response. However, the stimuli and response alternatives were presented concurrently, so we cannot be sure that the influence was one-way or went in the assumed direction. It is possible that the visual stimuli (particularly emotional stimuli, such as the eye images used here) affected the individuals' perceptions of music. For *Angry*/Sad* trials, it may be that the visual stimuli colored participants' interpretation of the music, leading them to match the music with either one eye image or the other. In future studies, participants could hear the same excerpt but view different images with the excerpts. They would be asked to provide ratings about the affective value of the music. If emotive visual stimuli alter perceptions of musical emotion, one would expect ratings to differ with different images.

The present study was limited in several ways. First, with regard to the Non-critical trials (trials in which the target response was not available), results for the 9 non-critical trials provide some evidence for Bigand et al.'s (2005) finding that the primary dimension for musical emotional identification is valence (positivity vs. negativity). In the present study, participants were asked to select the "*best* response," and the data show that there may have been a preference based on valence when the target was not available. For the "Angry" musical excerpt, the *sad* label and eye image were chosen far more often than the *happy* label and eye image. This was true across trial types. Likewise, for the "Sad" excerpts, the *angry* verbal and eye label was selected far more than *happy*. Since there was not positive valence foil to be matched with *happy*, we would expect chance agreement when given *sad* and *angry*. This was true in the ME trial, but not in the MW trial, where *sad* was selected by 10 of 12 participants. It is possible this outcome

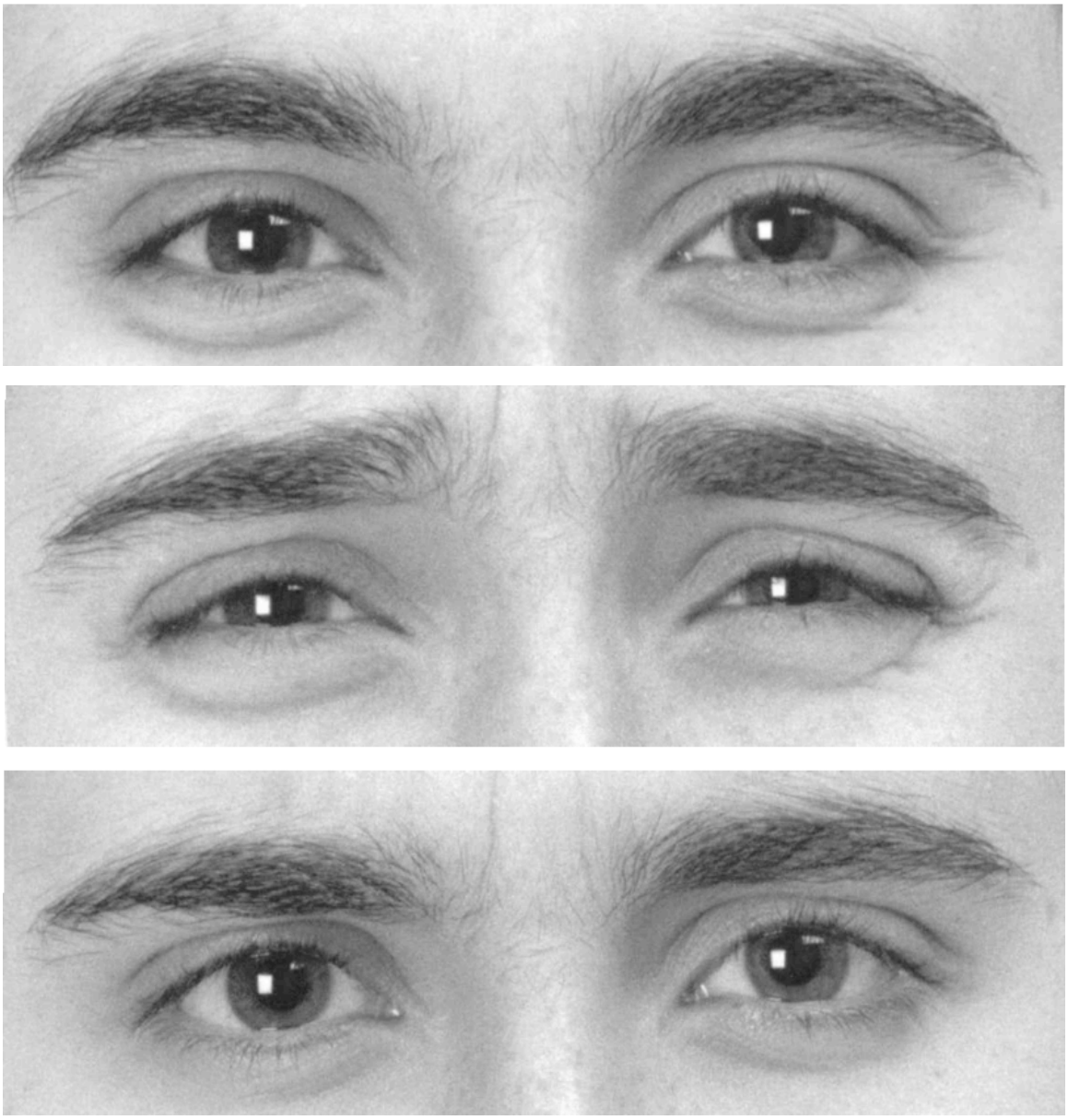
was an artifact of a small data set, or, alternatively, that participants could have been using some strategy that we are not aware of to either support *sad* or eliminate *angry* for this trial.

Another limitation was that *happy* stimuli may have been easier to identify, given that the other two responses, *sad* and *angry*, were more similar (both are negative). It would be desirable to have two negative and two positive stimuli in future studies. In addition, it would be beneficial to have counter-balanced the two blocks, such that half of the participants received Block 1 first and half received Block 2 first. Future studies should incorporate these elements to avoid these limitations.

Finally, we should take care not to generalize results found with these musical excerpts. The musical excerpts used in the present study were created and validated by Vieillard et al. (2008), which are intended to elicit emotion due to intentionally composed musical structure. It should be noted that musical emotions can also be expressed through performance choices of the musician (or, presumably, conductor). This kind of emotional expression was not intentionally measured here. However, the effect of performance practice is also likely to be relevant for listeners' emotional experiences. Future studies could investigate the effects that performer expertise and performer intention may have on listeners' emotional interpretations.

Appendix A

Stimuli



Eye images (top to bottom) *happy*, *distressed*, and *disgust* (Baron-Cohen et al. (1997))

Appendix B

Forms and Surveys

For the following items, please listen to the short audio clips. Each clip lasts about 10 to 15 seconds.

Pick the image or word that you think BEST matches the EMOTION of the clip you just heard.

Even if you do not think that either image or word matches the clip's emotion, you must pick one to continue.

Please listen to each clip for its entirety, even if you have heard it before.

Survey Powered By Qualtrics >>

00:00

00:00

sad

happy

In the following items, you will see an image of eyes.

Please choose the word that you think BEST matches the EMOTION of the eyes.

Even if you do not think that either word matches the image's emotion, you must pick one to continue.

Survey Powered By Qualtrics

>>

- angry
- happy

Survey Powered By Qualtrics

>>

DEBRIEFING FORM
The Pennsylvania State University

Title of Project: Emotional Affect in Music
Principal Investigator: Prof. David A. Rosenbaum
Department of Psychology
448 Moore Building
Dar12@psu.edu

Thank you for participating in our research study entitled *Emotional Affect in Music.* Since the goal of psychological research is to determine how people react naturally, it is sometimes necessary that participants do not receive complete information until the completion of the experiment. Since the experiment is now complete, we can discuss the purpose and goals of this study. Please do not share this information with others, in order not to influence those who might be future participants.

In this study, we are exploring the way emotions are communicated through music. Research has already shown that people have general agreement about the emotions of musical pieces, as you may have noticed in your own experiences with music. However, there are still many questions to be answered. The goal of this research is to determine whether people will link musical clips with images of eyes as strongly or more strongly than emotional words. We would also like to see whether responses are different between those without and with formal musical training. Your responses may have implications for the way that we understand music and the emotions music can convey.

We hope you enjoyed your experience participating. If you have any questions, please feel free to contact us. There are two contact email addresses listed below for your reference. Thank you again for your participation.

If you have any questions or concerns about the research please feel free to contact Haley Kragness at hik5084@psu.edu. You may also contact the faculty sponsor, David A. Rosenbaum, Ph.D., at dar12@psu.edu.

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ACADEMIC VITA

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Education

The Pennsylvania State University, University Park, PA May 2013
Schreyer Honors College
Major: Psychology, Biological/Evolutionary Science Option
Bachelor of Science with Honors in Psychology
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Research Experience

Trainee, Auditory Cognitive Neuroscience May-August 2012
Funded by Natural Science and Engineering Research Council of Canada
Department of Psychology
University of Toronto Mississauga
Dr. Sandra E. Trehub, Infant and Child Studies Centre

- Helped to design a two-part research project to explore the perception and interpretation of prosodic cues in development
- Learned basic programming to present auditory and visual stimuli and collect input
- Recruited, scheduled, and ran subjects
- Collected and analyzed data
- Presented a poster at the Auditory Cognitive Neuroscience Workshop in Montreal
- Discussed results in a journal-style paper
- Assisted with other projects in the lab, such as a conditioned head-turn paradigm for six-month-old infants, and helped to maintain and coordinate lab calendars

Undergraduate Research Assistant August 2011-May 2013
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Dr. David A. Rosenbaum, Laboratory for Cognition and Action

- Designed, executed, and wrote an honors thesis exploring the link between linguistic, facial, and musical expressions of emotion
- Reviewed literature in the fields of cognition and motor coordination
- Attended weekly lab meetings and confer with other lab members about various projects ongoing in the lab
- Clearly articulated and presented my own plans, as well as accepted and incorporated criticism

Student (Honors Course in Research Methods)
The Pennsylvania State University, University Park Fall 2011
Dr. Theresa Vescio, PSYCH 300H

- Performed a small study using attitudes scales
- Created an attitudes scale to measure participants' "openness to other cultures"
- Formulated hypotheses, generated surveys, tested validity, and performed analyses (using ANOVA) for responses

Summer Volunteer Summer 2010
Department of Psychology
The Pennsylvania State University, Berks Campus
Dr. David S. Bender

- Assisted in reviewing literature relevant to a future study in educational psychology
- Summarized articles both in writing and in weekly meetings with Dr. Bender

Academic Honors

Costello Family Scholarship	2013
Norene E. Purcell Memorial Scholarship	2012
Trainee – Auditory Cognitive Neuroscience Network	2012
Evan Pugh Scholar Award	2012
Phi Beta Kappa	2011
Psi Chi Honor Society	2011
President Sparks Award	2011
President's Freshman Award	2010
Schreyer Academic Excellence Scholarship	2009
Robert C. Byrd Scholarship	2009
National Merit Scholar Finalist	2009

Leadership and Involvement

Fundraising Chair – Global Human Rights Brigades 2012-Present

- Organize fundraisers
- Write grant applications
- Create partnerships with local and national law firms

Member – Global Human Rights Brigades 2011-Present

- Spent a week in a rural Panamanian community over spring break
- Interacted with community members and Panamanian lawyers
- Offered pro bono legal advice and legal workshops

Adult English as a Second Language Tutor 2012-Present

- Develop and implement English lessons with an adult English language learner
- Work individually with English language learner for three hours a week

Music Director – Wilson Summer Drama Camp August 2011

- Led vocal and theatrical warm-up activities
- Taught music and promoted enthusiasm and excellence in the performing arts to children K-8

Elementary ESL Tutor – State College School District 2010-Present

- Work individually with elementary English language learner for one hour a week

Penn State University Music 2009-Present

- Penn State University Marching Blue Band
- Concert and Symphonic Bands
- Accompanist and pit musician for various theatrical endeavors