Can Musical Aptitude Predict Language Skills? Exploring the Connection Between Pitch, Rhythm, and Phonological Decoding

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ABSTRACT

This study contributes to the body of literature differentiating the effects of innate musical aptitude from those of formal music training. Few studies have examined how distinct components of music, such as pitch and rhythm perception, are differentially related to phonological skills. To consider the phonological element, a study was conducted in which a total of 20 individuals were recruited from the MTSU community. All participants were native English speakers, aged 18–22, and reported no history of hearing or language disorders. The study found that musical training did not predict awareness and did not demonstrate a transfer effect beyond innate musical ability, and that the relationship between musical rhythm and linguistic rhythm aptitudes shows potential transfer across these domains.

Introduction

The power of music is ubiquitous. Music is fundamental to the human condition, enlightening our lives through its beauty and its singular capacity to elicit emotion. While the aesthetic properties of music are widely appreciated, the cognitive underpinnings of musical ability, and its potential connections to other cognitive domains, such as language processing, remain fertile ground for inquiry. Theories abound on the conception of musical ability. These include music training and musical aptitude. Music training is defined as formal instruction and continued practice, resulting in enhanced musical performance and understanding. Musical aptitude, on the other hand, denotes a natural predisposition, a talent characterized by perceptual abilities such as the capacity to recognize different pitches and rhythms. This study set out to explore the relationship between musical aptitude—specifically, the ability to discern pitch and rhythm—and phonological skills, with a focus on the role of phonemic and prosodic awareness, two linguistic skills essential to understanding spoken language.

Link Between Phonological Processing Skills and Language Abilities

Phonemic decoding and prosody awareness are key elements of spoken language production as well as comprehension. Each represents a phonological processing skill. Phonemic decoding is the ability to identify, understand, and manipulate phonemes—the smallest units of sound in language. Prosody awareness involves the sensitivity to, and understanding of, the "music" of speech, in which rhythms, stresses, and intonations contribute to the communication of meaning and emotion. While these skills are crucial for spoken language, evidence suggests they are also important for reading. Phonemic awareness, for example, allows readers to understand how different phonemes are represented by a combination of letters that help individuals recognize written words and their meaning. According to Carruth (2019), thedevelopment of more advanced reading skills relies heavily on a solid foundation in these basic skills. As for prosody awareness, the ability to decipher the complex stresses and intonations of speech is essential to language, and thus to reading. Research on morphological awareness from Clin et al. (2009) suggests that after accounting for age, nonverbal and verbal abilities, working memory, and phonological awareness, prosodic sensitivity and morphological awareness remain some of the strongest predictors of reading ability. The correlation between these two components may indicate a connection between prosody awareness and reading ability.

Neurocognitive Overlap Between Language and Music

Evidence from cognitive neuroscience research supports some degree of overlap between music and language. For instance, Patel (2003), a leading cognitive neuroscientist specializing in this topic, suggests from neuroimaging data that musical syntactic processing engages brain regions associated with language. According to Drakoulaki (2024), evidence also suggests that language and music rely on hierarchical cognitive control, a neurocognitive mechanism that manages goal selection, maintenance, and inhibition within a structured and timedependent framework. In addition, music relies primarily on scales, rhythms, harmonies, and melodies that follow rules and patterns. Language is organized through phonemes, morphemes, syntax, grammar, and vocabulary, all of which generate meaning through structured patterns. Thus the relationship between music and language development is of key interest. Phonemic awareness, for example, is intertwined with music. According to Eccles et al. (2021), music discrimination skills predict phonemic awareness because both the auditory musical tones and speech phonemes are processed in overlapping brain regions. This supports the argument regarding perceived interconnectedness. The second element of prosody awareness is also affected by music related content. In a research study on music and speech prosody, Hausen etal. (2013) found evidence that the perception of rhythm may connect speech prosody perception with music perception. The article's design consists of computerized tasks measuring pitch perception, visuospatial perception, and speech prosody (i.e. word stress) perception.

Relationships Between Musical Ability and Language Skills

According to a study by Anvari et al. (2002) with children ages 45 years old, music perception skill is related to phonological awareness. Additionally, recent findings suggest that improvements in phonological awareness can be observed after musical training. For example, in a study by Vidal et al., (2020) on children as young as 4, music classes, provided at a frequency of one 45minute lesson per week over 30 weeks, resulted in greater improvement in phonological awareness skills compared to visual arts training. This may be partially due to the awareness of rhythm, stress, and intonation involved in music and phonological comprehension. There is a growing body of research that suggests an interconnectedness between language and music. This hints at a potential crossdomain transfer of skills. To start with, music and phonological awareness are potentially related. In a metaanalysis on music training and its effects on phonological awareness involving 13 different studies, Gordon et al. (2015) suggests that because of their shared auditory nature, music training may have a greater impact on phonological awareness than on reading. In addition, Gordon et al. (2015) suggests that there are better phonological skills in those with music experience than their nonmusical peers. It is important to note that the shared auditory aspects of music and language, and their inherent structural hierarchical similarities, could be a reason why they appear to be connected. The syntactic rules and sheet music rules share a level of hierarchical organization that is built from smaller parts to larger ones, such as in the case of a quarter note versus a half note.

As a result, music training could benefit individuals with language or reading difficulties. After 7 months of music training in a randomized controlled trial involving dyslexic children, Flaugnacco et al. (2015) found rhythmic reproduction, rather than working memory or auditory attention, was the strongest predictor of phonological awareness. In line with this study, Dumont et al. (2017) found that 26 children with musical experience outperformed 30 children without musical experience in auditory processing and phonological awareness.

However, it is important to note that recent studies argue that some of the association between musical ability and language skills may be at least partially due to preexisting differences in musical aptitude rather than the music training itself (Swaminathan and Schellenberg, 2020). Thus, the respective role of musical aptitude versus music training remains to be fully understood.

Thesis Statement

While there are several studies looking at the association between musical ability and phonological skills, there is a lack of research that seeks to more specifically distinguish the effects of musical aptitude versus music training. Another gap in literature is the limited number of studies exploring how specific aspects of music (e.g., pitch versus rhythm perception) relates to phonological skills. Therefore, the main research questions that were examined in the present study are as follows: 1) Does music aptitude predict phonemic and/or prosody awareness after controlling for musical training experience? 2) Do specific types of music aptitude (pitch versus rhythm) have stronger relationships with distinct phonological skills (phonemic or prosody awareness)?

To address these questions, participants completed a series of validated measures assessing phonemic awareness and lexical stress sensitivity. Musical abilities were measured using a normed assessment of music aptitude and a music interest questionnaire to determine their level of musical training. Multiple regression analyses were used to explore how musical aptitude and training predict performance on measures of phonological awareness (phonemic awareness and lexical stress sensitivity). Based on previous studies (Swaminathan and Schellenberg, 2020), it is predicted that musical aptitude will have a stronger association than music training with prosody and phonemic awareness. It is hypothesized that rhythm will have a stronger association than pitch discrimination with prosody skills, while both pitch and rhythm will be associated with phonemic awareness.

The significance of the study includes potential implications of this research for educational and language practices. For all research, there is always a question of why it is meaningful to look at phonological awareness and music. Why this particular topic? This topic was chosen because phonemic and prosody awareness each play a complementary role not just in spoken words, but also in reading development. In this case, it comes down to two main topics. To start, there may be possible interventions for language disorders utilizing music. Secondly, there may be educational benefits to using music in a classroom setting. Could these findings inform us of music education curricula or interventions for language development? For example, songs are used in classrooms to facilitate learning. Using music to aid in essentials like reading can boost these skills. In language disorders, increased prosody and phonemic awareness could possibly be related to understanding of language's structure and word stresses. The contribution the study could make to the broader field of research on music cognition and language development would be an important addition to the literature. It could also provide new insights into the mechanisms underlying crossdomain transfer of skills.

Methodology

Participants

The sample size was 20 participants recruited from the MTSU community, as well as the psychology research pool. Their ages ranged from 18 to 22 years old. Participants were native speakers of English with no history of hearing or language disorders. Participants also had normal or correctedtonormal vision (i.e., contact lenses or glasses). Participants signed an informed consent form before beginning the experiment. They also filled out a demographic questionnaire.

Measures

Music Aptitude. The Advanced Measures of Music Audiation (AMMA) created by Gordon (1989) assesses participants' music aptitude, focusing on inherent musical potential rather than acquired skills. Participants listen to pairs of melodies and judge whether they are the same or different. When answering "different", participants must specify if they believe the melodies are rhythmically or tonally different. The AMMA yields two subscores: Tonal, which evaluates the perception of melodic patterns, and Rhythm, which assesses the perception of rhythmic patterns. This standardized assessment is designed for individuals from grade 7 through adulthood.

Music Training. Participants complete a sixquestion Music Interest Questionnaire (MIQ). It is a selfreport measure that explores their musical experiences, including skills, practice habits, and achievements.

Lexical Stress Sensitivity. The Test of Prosody via Syllable Emphasis (TOPSY) developed by Nayak et al. (2024) measures the sensitivity to lexical stress in words. The TOPSY is a computerized test that consists of 28 multisyllabic spoken words. During each trial, participants listen to a recorded multisyllabic word while simultaneously viewing a visualrepresentation of the word segmented by syllable on the screen. Participants are instructed to identify which syllable has the main emphasis and click on the number that represents the syllable they perceived as stressed.

Phonemic Awareness. Participants' ability to understand and manipulate the sounds in spoken words (i.e., phonemes) is assessed using the phonemic proficiency subtest of the Wechsler Individual Achievement Test - Fourth Edition (WIAT4). Participants verbally respond to questions that ask them to change sounds within words, such as removing, replacing, or adding a phoneme to make new words (e.g., say "cat" but change the /c/ sound to a /b/ sound in it). The questions are presented through audio recordings, and the examiner gives feedback after each answer. The final score is based on both how quickly and how accurately the participant responds.

Experimental Procedure

Upon arrival, participants were greeted by the experimenter and provided with informed consent. They also filled out a demographic questionnaire. Following consent, participants completed a series of assessments, as described previously, including measures of musical training, musical aptitude, lexical stress sensitivity, and phonological awareness. The order of the musical (training and aptitude) and phonological (lexical stress and awareness) measures was counterbalanced across participants. The total testing session is expected to last approximately one hour.

Statistical Analysis

Statistical analyses were conducted using Jamovi software. Pearson correlations were first calculated to explore the relationships among all experimental measures. To address the first research question, determining the unique contribution of musical aptitude and musical training, two separate hierarchical multiple regression analyses were performed. In both regressions, the independent variables were entered in two steps based on their presumed temporality: Musical Aptitude (comprising AMMA Tonal and AMMA Rhythm scores) was first entered to account for innate ability while Musical Training was entered next to determine if it explains significant unique variance in the outcome variables above and beyond aptitude. The outcome variables for these two regressions were lexical stress sensitivity and phonemic awareness.

To address the second research question investigating the specific relevance of the two musical aptitude components, two separate multiple regression analyses were performed for the Aptitude components. AMMA Tonal and AMMA Rhythm scores were used independent variables, while the outcome variables for these two regressions were lexical stress sensitivity and phonemic awareness.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics for the Advanced Measures of Music Audiation tonal (AMMA T) and rhythm (AMMA R) subtests, the Test of Oral and Written Language Skills (TOPSY) Lexical Stress Perception subtest, the Wechsler Individual Achievement Test Phonemic Decoding subtest (WIATPD), and musical training in hours per day.

Table 1

Descriptive Statistics

	Mean	Median	SD	Range	Minimum	Maximum
WIATPD	58.60	59.00	11.57	50	26	76
TOPSY	54.63	46.40	22.33	67.9	32.1	100
AMMA T	24.95	25.50	5.44	18	18	36
AMMA R	26.25	26.00	4.83	19	16	35
Music Training	1.45	1.00	1.43	5	0	5

Correlation Analyses

To examine the relationships among all experimental variables, Pearson correlations were calculated among music training experience, specific music aptitudes (pitch and rhythm), and phonological awareness measures (phonemic and prosody). The resulting correlation coefficients, along with their significance levels, are presented in Table 2. Notably, music training was only significantly correlated to lexical stress perception ($r = 0.54$), but not phonemicdecoding ($r = 0.31$). AMMA rhythm performance was significantly and positively correlated with both phonological measures (lexical stress perception $r = 0.54$, phonemic decoding ability 0.52) while AMMA Tonal performance was only significantly correlated with lexical stress perception ($r = 0.48$) and not phonemic decoding ($r = 0.32$).

Table 2

Correlation Matrix

	PD	TOPSY	AMMA T	AMMA R	Music Training
PD	—				
TOPSY	0.57**	—			
AMMA T	0.32	0.48*	—		
AMMA R	0.52*	0.54*	0.79***	—	
Music Training	0.31	0.53*	0.62**	0.58**	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Hierarchical Regression Analyses

A twostep hierarchical linear regression was performed to examine the unique contribution of Music Training to the prediction of the phonological variables, after accounting for the effect of music aptitude (total AMMA score).

Phonological Decoding. In Step 1, total AMMA was entered, and the model approached statistical significance, $F(1,18) = 4.29$, $p = 0.053$, explaining 19.2% of the variance in phonological decoding ($R2 = 0.19$). Total AMMA also approached significance as a unique predictor ($\beta = 0.522$, $t(18) = 2.07$, $p = 0.053$). In Step 2, Music Training was added to the model. The inclusion of Music Training resulted in a nonsignificant change in variance explained ($\Delta R2 = 0.002$, $F(1,17) = 0.024$, $p = 0.878$).

Lexical Stress Perception. In Step 1, total AMMA was entered as the sole predictor. This model was statistically significant, $F(1,18)=7.35, p=0.014$, and accounted for 29.0% of the variance in TOPSY ($R2 = 0.290$). Total AMMA was a significant positive predictor ($\beta = 1.24$, $t(18) = 2.71$, $p = 0.014$). In Step 2, Music training was added to the model. While the overall model remained significant ($F(2,17) = 4.48$, $p = 0.027$), the inclusion of music training resulted in a nonsignificant increase in explained variance ($\Delta R2 = 0.055$, $F(1,17) = 1.43$, $p = 0.248$). Therefore, Music Training did not account for a significant unique proportion of the variance in TOPSY beyond that explained by Total AMMA.

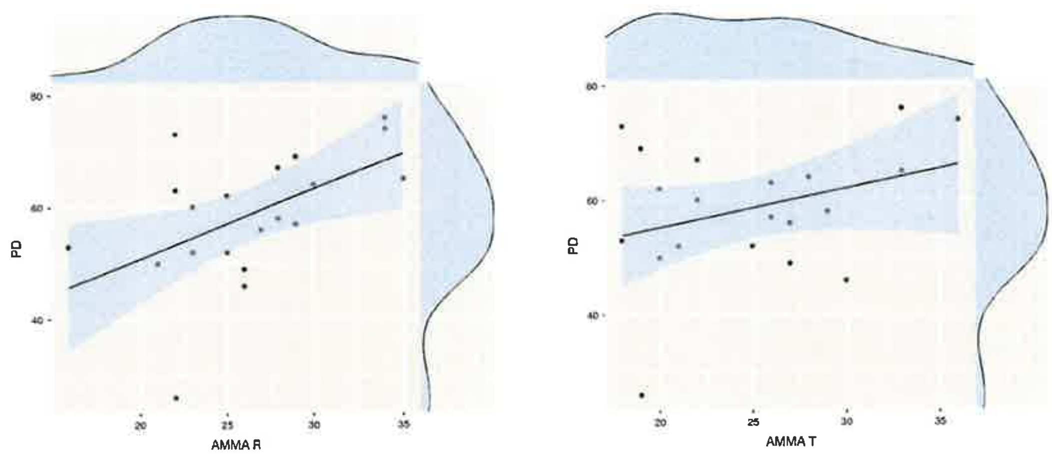
Multiple Linear Regression

A linear regression was conducted to examine the relationship between each AMMA subscore (tonal and rhythm) and each phonological dependent variable.

Phonological Decoding. The model significantly explained a moderate proportion of the variance in phonemic decoding (F(2,17) = 3.53, p = 0.05, R2 = 0.29). AMMA rhythm was a statistically significant positive predictor (β = 1.702, t(17) = 2.143, p = 0.047), holding AMMA tonal constant. However, AMMA tonal was not statistically significant (β = −0.511, t(17) = −0.724, p = 0.479). See Figure 1.

Figure 1

Relationship Between Musical Aptitude and Phonological Decoding Skills

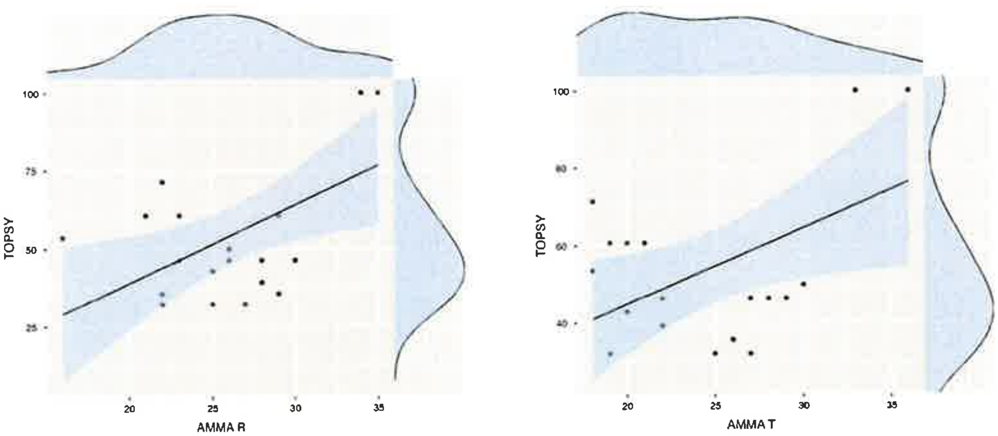


Note. The scatterplots display the relationship between Phonological decoding scores (on the yaxis) and musical rhythm scores (left panel) or musical tonal scores (right panel). The solid black line represents the linear regression fit, illustrating the overall trend. Shaded gray areas surrounding the regression line indicate the 95% confidence interval for this fit. The density plots in the top and right margins show the distribution of each variable.

Lexical Stress Perception. The model was also statistically significant, (F(2,17)=3.67,p=0.047), explaining 30.2% of the variance in TOPSY scores (R2 = 0.302). Despite the overall model being significant, neither individual predictor contributed uniquely and significantly to the model (AMMA rhythm: β = 2.007, t(17) = 1.317, p = 0.205; AMMA tonal: β = 0.563, t(17) = 0.416, p = 0.683), suggesting that each musical aptitude when considered together, contribute meaningfully to the variance in the outcome, but their shared variance or combined effect is what drives the significance, rather than the unique contribution of any one of them. See Figure 2.

Figure 2

Relationship Between Musical Aptitude and Lexical Stress Perception



Note. The scatterplots display the relationship between lexical stress perception scores (on the y-axis) and musical rhythm scores (left panel) or musical tonal scores (right panel). The solid black line represents the linear regression fit, illustrating the overall trend. Shaded gray areas surrounding the regression line indicate the 95% confidence interval for this fit. The density plots in the top and right margins show the distribution of each variable.

Discussion

The present study aimed to clarify the relationship between musical aptitude, musical training, and phonological skills. Specifically, two research questions guided this investigation: (1) Does music aptitude predict phonemic and/or prosody awareness after controlling for musical training experience? (2) Do specific types of music aptitude - tonal versus rhythm - have stronger relationships with distinct phonological skills such as phonemic or prosody awareness?

Findings are expected to contribute to the growing body of research linking music and language by more precisely distinguishing between the effects of inherent musical aptitude and formal music training. It was predicted that musical aptitude, rather than training experience, would show stronger associations with both prosody and phonemic awareness. Moreover, rhythm perception was hypothesized to be more strongly related to prosody skills, whereas both rhythm and pitch are expected to correlate with phonemic awareness. As suggested earlier by Eccles et al. (2021), music discrimination skills or music aptitude predict phonemic awareness because both the auditory music tones and speech phonemes are processed in brain regions that overlap. After accounting for the study conducted, this was found to be evident in the correlational data.
In addition, Hausen et al. (2013) found evidence that suggested that the perception of rhythm may connect speech prosody perception with music perception, which is also seen in the correlational data below.

Music Training, Musical Aptitude, and General Phonological Awareness

This section will focus on the first question: Does music training predict phonemic and/or prosody awareness after controlling for musical aptitude? The results related to music training experience (duration) as a predictor of phonemic and prosody awareness were interesting. Music training was only significantly correlated to lexical stress perception, but not phonemic decoding. Considering the control variable of general musical aptitude (hierarchical regression analyses) in phonological decoding, the inclusion of music training resulted in a nonsignificant change in variance explained. In lexical stress perception, music training did not account for a significant unique proportion of the variance in TOPSY beyond that explained by Total AMMA. Musical training therefore did not predict awareness and did not suggest a transfer effect.

Differential Relationships Between Specific Musical Aptitudes and Phonological Skills

This section directly tackles the second question: Do specific types of music aptitude (pitch versus rhythm) have stronger relationships with distinct phonological skills (phonemic or prosody awareness)? Pitch aptitude was more strongly related to prosody awareness, possibly due to shared processing of acoustic variations like pitch/intonation. Rhythm was related to both prosody awareness and phonemic decoding. It appeared that the relationship between musical rhythm and linguistic rhythm shows potential transfer across domains, versus a general cognitive enhancement.

Theoretical and Practical Implications

Improved sensitivity to these prosodic/lexical stress cues then provides a clearer structural framework for the sublexical phonemes, thereby facilitating the segmentation and manipulation required for phonemic decoding. In essence, the ability to parse words prosodically supports the ability to parse them phonemically. Thus, the ability to be attuned to lexical stress can help in further understanding words by their phonemes.

Limitations and Future Directions

The study had a small sample size (N=20). There are inherent risks in research with smaller sample sizes, such as generalizing the results to other similar topics. All research findings should have replication studies performed to see how reliable the results are. The data in the study are correlational and cannot definitively prove causality (the arrows in the mediation model reflect statistical relationships, not confirmed developmental direction). Future research could replicate the study with larger, more diverse samples (including various age groups or clinical populations) and conduct longitudinal or intervention studies where rhythmic skills are explicitly trained and then measure changes in both lexical stress perception and phonemic decoding to establish the developmental direction of the pathway.

Conclusion

While several studies have examined the relationship between musical ability and phonological skills, there remains a lack of research that clearly distinguishes the effects of musical aptitude (innate ability) from those of music training (experience-based learning). Another overlooked piece in the literature concerns the limited number of studies exploring how specific aspects of music, such as pitch versus rhythm perception, relate to distinct phonological skills. This study was aimed at providing information on this relative gap in the body of literature.

These findings suggest that interventions focused on rhythmic skill development could serve as a promising, engaging, and nonlinguistic approach to indirectly enhancing prosodic sensitivity, which may contribute to foundational literacy and reading skills. For instance, music-based interventions, such as rhythm and song-based activities, could be used to strengthen phonological skills in those with language or reading disorders, improving sensitivity to topics such as lexical stress. Similarly, incorporating music into classroom learning may enhance foundational language skills and reading acquisition.

Ultimately, this area of research points to the powerful bridge between the domains of music and language. These skills, rooted in pitch, rhythm, phonemic decoding, and lexical stress perception, appear to support a shared cognitive and neural architecture that facilitates both musical understanding and linguistic competence. In revealing this deep interconnection, the study contributes to a growing body of evidence that rhythm and prosody are not merely parallel abilities, but rather core mechanisms that bind music and language together at their most fundamental levels of human communication.

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