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RELATIONSHIP BETWEEN SELF-RATED MUSICAL COMPETENCE AND AUDITORY PROCESSING IN INSTRUMENTALISTS

Yoshita Sharma[BEF], Harshada Mali[BEF], Nisha Venkateswaran Kavassery[AC-E]

Audiology, All India Institute of Speech and Hearing, Mysore, India

Corresponding author: Nisha Venkateswaran Kavassery, Audiology, All India Institute of Speech and Hearing, Manasagangothri, 570006, Mysore, India; email: nishakv1989@gmail.com

Contributions:
A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

Abstract

Introduction: Although the benefits of musical training have been shown to affect a number of auditory processes, the question of how self-rated musical competence correlates with auditory perception remains largely unexplored. The present study aimed to investigate how self-perceived musical competence correlates with musicians' ratings of their own abilities in speech perception, spatial hearing, and sound qualities.

Material and methods: The *Edinburgh Lifetime Musical Experience Questionnaire* (ELMEQ) was administered on 57 instrumentalists aged 19 to 53 years (mean = 25.1 ± 4.9 years, 34 males and 23 females). All had normal hearing and had undergone formal training on musical instruments for 1–2 years. All of them also regularly practised music for at least 1–2 h/week. Based on their ELMEQ scores, they were divided into two groups: low (ELMEQ score ≤ 7; $n = 12$) and high (ELMEQ score ≥ 11; $n = 16$; self-perceived musical competence. Participants were sent a modified questionnaire from the *Speech, Spatial and Qualities of Hearing Scale* (SSQ) using Google forms, and the data statistically analysed.

Results: A Mann–Whitney *U*-test showed that participants with high self-rated musical competence had significantly higher ratings on the spatial hearing and sound qualities sub-domains of SSQ compared to their counterparts who had lower ELMEQ scores. However, both groups scored about the same on the speech perception domain of SSQ. A Spearman test revealed a moderate to strong positive correlation between self-rated musical competence and SSQ ratings in each domain.

Conclusions: The findings show that instrumentalists with high self-rated musical competence exhibited high proficiency in the spatial hearing and sound quality domains of auditory processing.

Keywords: instrumentalists • musical competence • speech perception • sound qualities • spatial hearing

ZWIĄZEK POMIĘDZY WŁASNĄ OCENĄ KOMPETENCJI MUZYCZNYCH A POZIOMEM PRZETWARZANIA SŁUCHOWEGO WŚRÓD INSTRUMENTALISTÓW

Streszczenie

Wprowadzenie: Chociaż wykazano, że trening muzyczny wywiera korzystny wpływ na wiele procesów słuchowych, to pytanie, jak własna ocena poziomu kompetencji muzycznych koreluje z percepcją słuchową pozostaje w dużej mierze niezbadane. Celem obecnego badania była ocena korelacji pomiędzy własną oceną kompetencji muzycznych a poziomem kompetencji w zakresie percepcji mowy, lokalizacji dźwięku i jakości dźwięku we własnej ocenie muzyków.

Materiał i metoda: Kwestionariusz *Edinburgh Lifetime Musical Experience Questionnaire* (ELMEQ) wypełniło 57 instrumentalistów w wieku 19–53 lat (średnia = 25,1 ± 4,9 lat, 34 mężczyzn i 23 kobiety). Wszyscy mieli słuch w normie i przeszli formalne szkolenie w zakresie gry na instrumencie muzycznym przez okres 1–2 lat. Wszyscy regularnie ćwiczyli granie przez co najmniej 1–2 godz. tygodniowo. Uczestnicy zostali podzieleni na dwie grupy na podstawie wyników kwestionariusza ELMEQ dotyczących kompetencji muzycznych w ocenie własnej: niskie (wynik ELMEQ ≤ 7; $n = 12$) i wysokie (wynik ELMEQ ≥ 11; $n = 16$). Uczestnicy otrzymali zmodyfikowany kwestionariusz *Speech, Spatial and Qualities of Hearing Scale* (SSQ 5,6) za pośrednictwem formularzy Google, a otrzymane dane zostały poddane analizie statystycznej.

Wyniki: Test U Manna–Whitneya pokazał, że uczestnicy, którzy wysoko ocenili swoje kompetencje muzyczne, uzyskali istotnie wyższe wyniki kwestionariusza SSQ w obszarach lokalizacja dźwięku i jakość dźwięku w porównaniu do uczestników, którzy uzyskali niskie wyniki ELMEQ. Obie grupy uzyskały podobny wyniki w obszarze percepcji mowy kwestionariusza SSQ. Test Spearmana wykazał istnienie średniej do silnej pozytywnej korelacji między własna oceną kompetencji muzycznych a wynikami SSQ w każdym obszarze.

Wnioski: Wyniki pokazują, ze instrumentaliści, którzy wysoko oceniali swoje kompetencje muzyczne, wykazywali wysoką sprawność przetwarzania słuchowego w zakresie lokalizacji dźwięku i jakości dźwięku.

Słowa kluczowe: instrumentaliści • kompetencje muzyczne • percepcja mowy • jakość dźwięku • lokalizacja dźwięku

Introduction

Enjoying music is universal, yet musical abilities vary from person to person. This variation also depends on training and musical competence. Musical competence refers to the ability to of a listener to perceive, remember, and discriminate musical melodies and rhythms [1]. It can consist of rehearsal, formal or informal training, and performances such as playing an instrument or singing. Research has shown that musical competence and exposure results in better cognitive abilities and slows down decline in aging-related auditory processes [1–3].

Musical background is linked to several other benefits as well, such as psychoacoustical abilities [4,5]. Studies suggest that, depending on the amount of musical experience, an individual's listening history can affect their cochlear frequency selectivity [6]. Pitch discrimination is also better in musicians than in non-musicians [7,8]. Musicians show better auditory attention [9,10], temporal processing skills [11,12], and speech perception in the presence of noise [12] compared to non-musicians. The literature shows that cortical auditory evoked potentials (CAEPs) are significantly enhanced in musicians [13].

The psychoacoustic correlates of musical competence can be found in tasks such as detecting the difference between two sequences of tones, intensity differences, and temporal differences. Self-perceived measures of musical competence involve the participant rating their ability to listen to music; perceiving features like rhythm, pitch, dynamics, melody, harmony, tone color, and texture; singing; and playing an instrument.

By assessing the musical competence and exposure of a person in detail, it appears theoretically possible to establish a link between musical experience and auditory domain-specific advantages. Several scales have been developed to measure musical competence: the *Self-assessment of Musical Skills and Experience* [14], *Ollen Musical Sophistication Index Questionnaire* [15], the *Music USE Questionnaire* [16], *Music Use and Background Questionnaire* [17], and the *Edinburgh Lifetime Musical Experience Questionnaire* (ELMEQ) [18]. They can also provide insight into other areas such as musical training, receptive sensitivity to music, how much time they invest in listening to music, and how much importance they give to music.

Research has established the impact of formal musical training on many auditory processes, including speech perception, sound qualities, and spatial hearing as measured by the SSQ scale [2,3]. However, there is scant evidence on the effect of self-perceived musical competence in musicians and its association with auditory performance in daily listening. The purpose of this study was to determine the relationship between self-perceived musical competence, as assessed using ELMEQ, and auditory performance (in terms of speech perception, spatial hearing, and sound qualities). In particular, the study aimed to determine correlations between self-rated musical competence and SSQ ratings.

Material and methods

Participants

A total of 57 musicians in the age range of 19 to 53 years (mean = 25.1 ± 4.9 years, 34 males and 23 females) participated in the study. All the participants had undergone formal training for musical instruments such as strings, piano, or percussion for 1–2 years, and they currently practised music for at least 1–2 h per week. The participants were divided into two groups based on their self-perceived musical competence abilities using ratings obtained from the *Edinburgh Lifetime Musical Experience Questionnaire* (ELMEQ) rating scale [18]. ELMEQ is a 30-item musical questionnaire with four sections which focus on musical instruments, singing, reading music notation, and listening to music. It provides information about the quantity and characteristics of musical training and expertise. It also includes questions about singing experience, music notation reading, self-rated musical ability, and music listening regardless of genre (classical, folk, pop, rock, or jazz). Here, a 5-point rating scale was used to assess the competence of the participants based on questions 6, 7, and 8 of the musical instruments section; these three questions are recommended by Okely et al. [18] for making assessments of self-perceived musical ability. Depending on the level of experience, participants can achieve a maximum possible score of 15. The questionnaire was administered using Google forms. The self-perceived ratings in ELMEQ were cross-checked against the questions on the *Music Performance Self-Efficacy Scale* [19].

Based on a pilot study, instrumentalists who scored above 11 were considered to have high self-perceived musical competence, while those who scored less than or equal to 7 were considered to have a lower musical competency. Participants who scored between 8 and 11 were not included in the data analysis because that was considered a grey area. Based on these criteria, two groups were formed: Group 1 comprised of 12 participants who had low competence (mean age = 24.8 ± 4.9 SD years, 8 males and 4 females) while Group 2 consisted of 16 participants (mean age = 24.1 ± 4.9 SD years, 11 males and 5 females) with high self-rated musical competence.

Procedure

Data collection for the study was done through Google forms. One Google form was designed to obtain demographic details and questions related to musical experience (**Table 1**). These questions were followed by administration of a simplified version of the Speech, Spatial and Qualities of Hearing Scale (SSQ v.5.6) [14].

Table 1. Google form used for data collection

Name: **Age:** **Gender:**				
Question	Options			
Have you ever learned to play a musical instrument?	○ Yes		○ No	
Which musical instrument do you play?	String instrument (guitar, violin, sitar, etc.)	Keyboard/piano	Percussion (drum, dholak, table, etc.)	Other
How long have you been playing the instrument?	0–2 years	2–5 years	More than 5 years	
Approximately how many hours do you currently play per week, on average?				
Have you ever played with a band, ensemble, or orchestra?	○ Yes		○ No	
If yes, how many years of your life did you play with a musical group?				

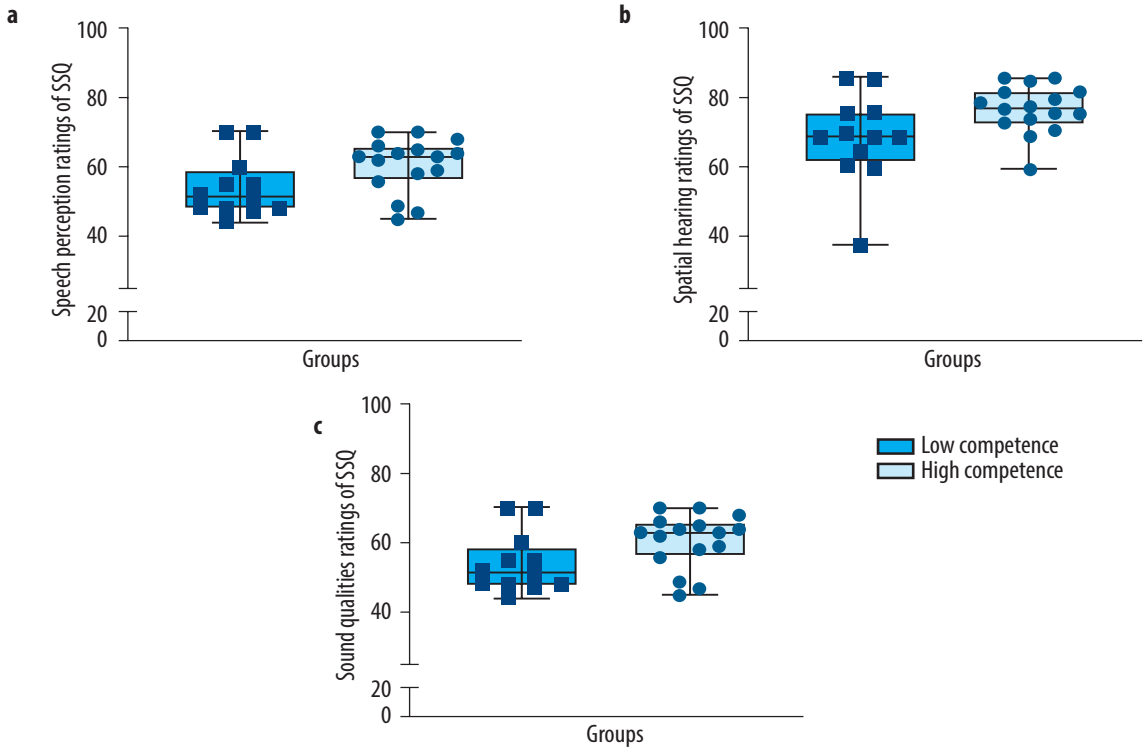

Figure 1. Box plots representing SSQ ratings for domains of speech perception **a**), spatial hearing **b**), and sound qualities **c**), divided according to musical competence. As indicated in Table 2, only **b**) and **c**) are statistically different. The plots show individual data points (symbols), medians (center lines), and inter-quartile ranges (Q1 and Q3)

SSQ was devised to self-assess hearing ability in different domains. It consists of a set of situations covering speech in noise, the spatial aspect of hearing, and qualitative judgments of hearing which are rated by the percentage of disability in the respective sections. The SSQ [14] was modified in the Google form so that the rating scale was simplified from a 10-point rating scale to a 5-point rating scale, where 1 denoted 100% difficulty, 2 denoted 75% difficulty, 3 denoted 50% difficulty, 4 denoted 25% difficulty, and 5 denoted 0% difficulty. There were 3 subsections: speech perception, having 14 questions; spatial hearing, with 17 questions; and sound qualities, 19 questions [14]. A participant's total achievable score was 70 for the speech section, 85 for spatial hearing, and 95 for sound qualities. Informed consent was obtained from the participants before beginning the survey. The study followed institutional

Table 2. Results of Mann–Whitney U-tests comparing SSQ ratings between the two groups (low and high self-rated musical competence). Bold text indicates observations with significant group differences; effect size is given for significant pairs

SSQ sub-domain	|Z|	*p*-value	Effect size, r_e
Speech perception	1.88	0.06	–
Spatial hearing	**2.09**	**0.03**	**0.39**
Sound qualities	**2.39**	**0.02**	**0.44**

Table 3. Results of Spearman correlation analysis (Sr) for the relationship between musical competence and three domains of SSQ

Association of musical competence with	S_r	*p*
Speech perception	0.43	0.02
Spatial hearing	0.50	0.006
Sound qualities	0.50	0.007

guidelines for biobehavioral research and was approved by the ethics committee. Participation in the study was voluntary and data confidentiality was ensured.

Statistical analysis

SPSS 25.0 software (IBM, Armonk, NY, USA) was used for statistical analysis. Speech perception, spatial hearing, sound qualities, and overall scores were the dependent variables in the study whereas musical competence of the participants was the independent variable. A Shapiro–Wilks test of normality was conducted to check if the data was normally distributed. A Mann–Whitney test was performed to check for group differences. A Spearman correlation test was administered to check the correlation between competence ratings on ELMEQ and self-perceived ratings of speech perception, spatial hearing, and sound qualities.

Results

A Shapiro–Wilk test revealed non-normal distribution ($p > 0.05$) of the data. The median scores along with the individual scores for each sub-section of SSQ are shown in **Figure 1**, revealing that participants with high self-perceived musical competence gave higher median ratings on all sub-sections of SSQ. These observations were statistically confirmed with a Mann–Whitney *U*-test. Results of the *U*-test (**Table 2**) revealed significant differences between groups categorized by self-perceived musical competence. Participants with higher self-perceived musical competence consistently demonstrated significantly higher ratings in spatial hearing ($p = 0.04$) and sound qualities ($p = 0.01$) compared to their counterparts with lower musical competence. However, such group differences were absent for speech perception ratings ($p = 0.06$), where both musical groups had similar ratings.

Spearman correlational analysis showed a moderate to strong correlation between self-perceived musical competence (measured by ELMEQ scores) and ratings on different SSQ domains (speech perception, spatial hearing, and sound quality) as shown in **Table 3**. While a moderate positive correlation was found between self-perceived musical competence and speech perception ratings ($S_r = 0.43$, $p = 0.02$) a strong positive correlation was observed between self-perceived musical competence score and both spatial perception rating ($S_r = 0.50$, $p = 0.006$) and sound qualities rating ($S_r = 0.50$, $p = 0.007$). In all the SSQ domains, the ratings tended to increase with an increase in self-perceived musical competence.

Discussion

The results of the study showed that there was a statistically significant effect of musical competence on spatial hearing and sound qualities perception in musicians. The low musical competence group produced lower ratings on both spatial hearing and sound qualities measures while the high musical competence group gave significantly higher ratings. However, these differences were not apparent for speech perception. The absence of group differences in speech perception lends support to the conclusion that both groups of musicians, irrespective of their self-perceived musical competency, enjoy equal advantage in the speech perception task.

The current study only pertains to self-perceived competence effects in instrumental musicians. However, the literature shows evidence, using a meta-analysis, that all musicians have an advantage on tasks related to speech in the presence of noise compared to non-musicians [12,20]. Inclusion of a non-musician group, and measuring self-perceived musical competence in them, would provide more insights.

In addition, in the present study the speech domain of SSQ comprised questions related to real-life listening, not those in noise. This discrepancy might explain the similar ratings between the two musical groups in speech perception, as musicians did not demonstrate a perceived advantage in everyday environments. Perhaps the incorporation of questions related to understanding speech perception in noisy conditions might reveal a concealed advantage.

Spatial hearing and the perception of sound qualities correlated better with high self-perceived musical competence. The higher the musical competence, the better were the scores in the spatial hearing and sound qualities domains. These findings support experimental studies that claim that musical experience has an effect on psychophysical abilities such as pitch perception and spatial hearing [1,4,8]. The better scores in the sound qualities domain in the high competence musician group can be explained by the evidence that musical training facilitates pitch discrimination abilities [6,7]. Positive correlation of musical competence with spatial hearing ability is documented in speech-in-noise studies [1,12]. Musicianship can also improve the

ability to segregate concurrently occurring sounds [21]. Better auditory stream segregation could be another possible reason for better spatial hearing abilities in the group with higher musical competence [10,22].

Overall, the impact of self-perceived musical competence on spatial hearing and sound qualities measures of SSQ suggest it would be useful to measure self-perceived musical competency in musicians prior to their inclusion in musicology studies. The presence of musicians with poor self-perceived competence might be a possible reason for seeing a lack of significant advantage, or reduced effect size, in findings from auditory processing tests. The findings of this study also emphasize the need for understanding domain-specific effects of musical competence using a variety of both psychoacoustical and electrophysiological tests. Future research should explore the impact of self-perceived musical competence across diverse populations (vocalists, different musical genres), and consider additional factors such as formal music education and early exposure to music.

This study has focused on musicians and their self-perceived expertise. Future research could encompass non-musical groups as well. Variables such as formal music education and childhood exposure to music could also be included. A screening questionnaire could be useful to assess these factors.

Conclusions

We found that self-rated musical competence was correlated with improved perceptions of spatial hearing and sound qualities. The group with high self-rated musical competence generally had better spatial hearing and more acute perception of sound qualities compared to the group who rated their musical competence as low.

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