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The Impact of Instrument Familiarity on Pitch Recognition in Non-Absolute Pitch Musicians

Finlay Gordon, Lucy Parr, Amy Simpson, & Emma Stephens*
Durham University
*All authors contributed equally to this article.

ABSTRACT

This study, a developed replication of Schellenberg and Trehub's (2003) study 'Good Pitch Memory is Widespread', examined the ability of musicians without absolute pitch (AP) to recall the pitch of well-known solos on both their first instrument and an unfamiliar instrument. Twenty-nine participants completed a survey, where they heard two musical extracts of four pieces (by Bach, Paganini, Beethoven, and Chopin) and were asked to identify which of the two had been pitch-shifted up or down. Our research expanded upon Schellenberg and Trehub's study, which indicated that non-AP adults do have memory for pitch, by focusing on non-AP musicians, and how instrument specialisation impacts results. We sought to illustrate that AP is a spectral phenomenon, rather than a binary trait, through an ecologically valid, repeated measures design experiment. Our main hypothesis, that AP memory is more accurate for extracts played on a musician's own instrument, was reflected in the results, as participants performed noticeably better at identifying pitches performed on their first instrument. Pianists scored higher than violinists overall, out-performing violinists in recognising pitch-shifting on their unfamiliar instrument, though violinists performed better at recognising pitch-shifting on their own instrument. However, statistical testing proved our results to be insignificant.

1. INTRODUCTION

Musical ability is segregated into different aspects: graded theory, practical exams, experience and, to an extent, the possession of absolute or relative pitch. AP is the ability to identify a certain tone without reference to an instrument or any other aids, (Miyazaki, 1988) and relative pitch is the identification of a particular tone via a reference pitch, and by calculating the interval between two notes. It has been suggested that AP is a rare ability, some suggesting it is only found in 0.0001% of the total population, (Ward, 1999) and that only around 20% of musicians have this ability (Hamilton, 2004). By completing this replication study, our hope is to demonstrate that musicians who do not have AP may be able to recognise when a piece is not in its original key, without reference to external factors.

There is much research into absolute and relative pitch within the musical community, with researchers arriving at multiple conclusions. Takeuchi & Hulse (1993) suggested that AP has a critical period in which it can be acquired, as most participants in the study had music lessons from early childhood. However, other research suggests alternative ideas for the inheritance of AP; for example, Leite, Mota-Rolim, and Queiroz. (2016) argues that AP is not something definitive, i.e. you either possess it or you don't, but rather is part of a continuum. Alike to conditions such as Autism or Asperger's Syndrome, which are part of a spectrum where the severity of the condition varies depending on symptoms, AP, according to Leite et al. (2016) is something many musicians possess, but to varying degrees. This is something this replication project aimed to examine, assessing whether musicians who claim not to have AP still have an ability to recognise when familiar classical works are not in their original key, therefore demonstrating that musicians have varying degrees of AP.

In addition, there has been research into the causes of AP and where this ability stems from, such as Brancucci, Dipinto, Mosesso, and Tommasi (2009a) who argues that there is a genetic cause for AP. He studied the brains of musicians and found a difference in cognitive processes when hearing pitches, and participants were found to have opposite hemispheric specialization when identifying pitches, depending on whether they have AP or not. Participants were divided into two groups, those with AP, and those without, based on a preliminary test for AP. The results showed that participants with AP favoured the left hemisphere and participants without AP showed bias towards the right hemisphere of the brain. Furthermore, Brancucci, di Nuzzo, and Tommasi (2009b) carried out further study, into retrieval of the correct pitch names in participants without AP. Using Latin note names, such as Do, Re, Sol etc, he suggested that musicians without AP may confuse labels when being asked to name a pitch. From a cognitive perspective, participants with AP did not struggle with the phonetics of pitch names, whereas those without AP became muddled with Latin note names containing similar vowels when identifying certain pitches. Both studies by Brancucci et al. (2009a) concluded, therefore, that there is both a genetic component associated with AP and also a strong ability in the correct verbal retrieval of note labels.

Whilst much of this research helps to contextualise the basis for the present replication project, there is a major criticism of studies focused on AP, as highlighted by Wong, and Wong (2013). It is suggested that the methodology used in studies of AP limits the validity of the study, decreasing ecological validity. As is the case for all contextual studies mentioned previously, the use of audiometric testing implies a laboratory setting and provides no correlation to the use of AP in the 'real world'. Asking participants to identify and label an isolated tone is a difficult

task and is not relevant to the use of AP in musical context, i.e. within musical works and within everyday life. Therefore, the results of studies that use audiometric testing do not have real life application which decreases ecological validity and, according to Wong, this needs to be developed; something which this replication study aims to improve upon.

Schellenberg and Trehub's 'Good Pitch Memory is Widespread' carried out in 2003 is the foundation upon which the current study is based. Their argument, like Leite et al. (2016), was that AP is part of a spectrum, but also that it is more prevalent and is not as rare a quality as is largely believed. In this experiment, the participants, a random group of college students, were played familiar clips from television soundtracks and adverts, some of which had been pitch shifted and some had not. Participants were then asked to recognise when clips had been pitch shifted. The participants in this study did not record having AP and were all non-musicians, however they were still able to identify pitch shifts, particularly when the stimuli were meaningful and familiar to them. This is an aspect that this replication study wants to enhance, to see if this skill can be seen in musicians who do not have AP, and to see if not only the stimuli impacts responses, but whether the instrument participants play is a contributing factor to participants being able to identify pitch shifts. The study by Schellenberg and Trehub (2003) has many strengths, as it has a repeatable method allowing results to be checked for reliability, and also its methodology, which increases the ecological validity of the study in comparison to previous studies.

With the extensions to the original study, the research questions for this replication project are as follows:

- Do non-AP musicians experience pitch recognition?
- Is recognition greater when the stimuli is meaningful to the participant?
- Are there any other factors that may affect the level of pitch recognition a musician may have?

By taking all this into consideration, we state a hypothesis:

- AP memory is more accurate when recalling whether a pitch shift had occurred in reference to instruments musicians play themselves.

2. METHOD

Design. For this study we used an online survey, made using Bristol Online Surveys, with a repeated measures design. Participants were asked if they had AP, what their first instrument is, their age group, where they are from, and their musical training background. All participants were recruited over Facebook, either through personal Facebook pages or through Facebook groups for music students and extra-curricular music societies at Durham University.

Participants. 52 participants took part in this study. Out of these, 29 were valid responses (as the rest either played both piano and violin, played neither, or were under age 18), of whom 17 were pianists and 12 were violinists. 28 participants were in the age range of 18-25, and 28 identified as being from the UK. Every participant reported having a classical background, but a number also had folk and jazz backgrounds, and six participants reported being self-taught. We did not ask for the gender of the participants as we felt that this was not a relevant data point for our study.

Stimuli. We chose extracts that we believed to be widely recognisable pieces, but which are likely to be better-known by players of the instrument for which they were written.

The stimuli were:
Violin: Paganini - Caprice No. 24
J.S. Bach - Partita No. 3, Prelude
Piano: Chopin - Prelude, Op. 28, No. 15 ('Raindrop')
Beethoven - Piano Sonata No. 14, Op. 27, No. 2, Movement 1 ('Moonlight')

In addition to being well-known, these extracts were all short (up to 20 seconds and taken from the start of the piece as this was assumed to be the most recognisable section of each piece) and expressed diverse tempi and moods, helping to keep participants stimulated. Each question contained the original extract and a pitch-shifted extract, with the order changed for each question so that the pitch-shifted clip wasn't always played first or last. Participants were presented with the stimuli in the order Paganini - Chopin - Bach - Beethoven by all the participants, as we did not think the order the extracts were heard in would impact their responses, and also due to the restraints of the Bristol Online Surveys tool. The extracts were made using clips sourced as MP3 downloads and then cut and shifted using Logic Pro X, and participants were presented with the clips embedded into the survey via SoundCloud. Extracts played in the original key were pitched-shifted up and back down, so there would be equal distortion on all the clips.

Task. The survey began with a small number of pre-survey questions, collecting contextual information about the participants. This included age range, location, first instrument, and musical background. Not only did this allow us to screen out invalid responses, but it allowed us to gather additional data upon which we might draw conclusions about musicians' memory for AP. Participants would listen to both extracts and then select which extract they believed had been pitch-shifted. We believe that the ecological validity of our study was increased by allowing participants to complete the study at a convenient time and place and by using extracts from musical pieces rather than stand-alone pitches.

3. RESULTS

Our results are shown here in both table and graph format. Within our study, we found that for both instruments participants performed better when answering pitch shift questions for their specialised instrument. As shown in Table 1 and Figure 1, pianists scored 80.60% when answering questions on piano solos and violinists scored 87.50% when

answering questions on violin solos. Table 1 and Figure 1 also show that participants performed significantly better when answering questions on solos performed on their specialised instrument, suggesting a link between familiar stimuli and performance in pitch shift recognition for non-AP musicians. Consequently, before statistical testing, Table 1 and Figure 1 can suggest that our hypothesis was met during the experiment and that non-AP musicians did perform better in pitch recognition tests when the stimuli was famous solos using the specific instrument that they played. However, by carrying out a chi-square statistical test, the results found within our experiment are proved not to be statistically significant as our P level for the test (p = .62) was greater than 0.05 (p < .05). Therefore, this reflects how our results may have been produced through chance and further testing would be required with a larger sample would have to be carried out to check this, even though the results are higher than the chance rate of 50%. Moreover, as the results are shown as not statistically significant we have to accept the null hypothesis; there is no significant difference between pitch recognition scores when using familiar and unfamiliar musical stimuli.

Table 1. Average Scores for Pianists and Violinists in Pitch Shift Test

	Piano	**Violin**
Total correct answers	73.60%	72.90%
Correct answers for own instrument	80.60%	87.50%
Correct answers for unfamiliar instrument	66.70%	58.30%

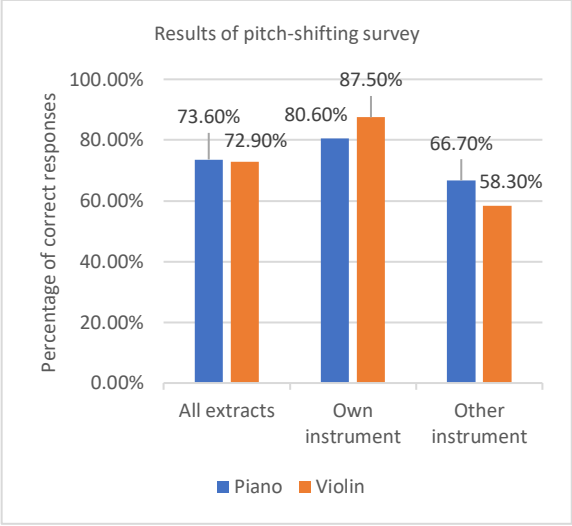

Figure 1. Bar chart of average scores for pianists and violinists in pitch shift test

Additionally, our results suggest that musicians have a higher ability for pitch memory than non-musicians do as our study produced higher results for the familiar stimuli than Schellenberg and Trehub's (2003) study using familiar stimuli did. In our experiment, 80.60% and 87.50% of answers were correct when hearing extracts on the participant's own instrument, in Schellenberg and Trehub's (2003) study where the results for familiar excerpts were (for the 1-semitone comparisons) 58% correct and (for the 2-semitone comparisons) 70% correct (Schellenberg and Trehub, 2003). This suggests that when non-AP musicians are tested with familiar material in a pitch shift recognition test they perform better than non-AP non-musicians as our results were considerably higher than those found in the original study.

4. DISCUSSION

The results of this experiment reflect the results of Schellenberg and Trehub (2003) experiment's as well as our own hypothesis that non-AP musicians will display more accurate pitch recognition skills when hearing extracts performed on an instrument they play themselves. Although statistical testing showed our results to be insignificant, the results still show evidence for pitch memory skills in non-AP musicians, and evidence for this being stronger in relation to their first instrument. The data we collected show high rates of correct pitch recognition in the non-AP musicians we tested across all four extracts. This reflects and improves upon the results found in the original study (which found 58% accuracy for extracts moved by one semitone and 70% accuracy for extracts moved by two semitones), although it is to be expected that our results would at least match those of the original study as the sample we used was more musically trained than that used by Schellenberg and Trehub (2003). Our results also show that the results achieved by musicians in AP related tasks are impacted by the instrument they are hearing when trying to recognise pitch – specifically that hearing extracts performed on an instrument they play themselves results in higher levels of accuracy. These conclusions support the idea of AP as a spectrum of abilities which can be impacted by a number of factors, both musical and personal. The disparity in the percentage accuracy between the violin and the piano extracts, regardless of the instrument the participant plays, is not large enough to draw any conclusions from. Similarly, the disparity in the percentage of correct answers for extracts moved up in pitch as opposed to extracts moved down in pitch, and in extracts moved by one semitone as opposed by two semitones is not large enough to be of note.

There are many avenues of research which could be explored in order to build on the findings of this study. Firstly, there could be value in replicating the study with some changes to the methodology. Changing the experiment from an online survey to a laboratory setting could increase the reliability and significance of our results as it would be easier to regulate the sound experience (for example, quality and volume) of each participant when listening to the extracts to ensure a consistent experience across all participants. However, a laboratory setting could be influenced by investigator effects and impact both the sample size, as the

survey would likely only be able to reach a smaller number of people, and the ecological validity of the survey as controls could be placed on the nature of the sounds heard by the participants.

Additionally, the study could be reproduced with changes to the sample group in order to observe how changes to personal factors such as age, location and playing ability on each participant's instrument impact the results. Due to the limited scope of our study (as we were only able to recruit people that we knew personally or via Facebook posts to groups known to us) the vast majority of our participants were aged 18-25 and based in the UK. The experiment could be repeated to see if stronger pitch recognition skills are demonstrated by older or younger groups of participants, or by participants in different continents as suggested by Deutsch, Henthorn, Marvin, and Xu (2006), in the study comparing Chinese and American/European students. Developing studies would also benefit from using a larger sample group. However, there are issues with exploring the impact of geographical location on AP skills as it would be extremely difficult to find stimuli that would be familiar and meaningful to all participants as such a variety of musical genres occur across the world. Moreover, many musical genres, for example folk, do not have a sense of grounded pitch in the manner of Western Art Music and often the music of these genres can be performed in any key, meaning the results of the study would be random and the experiment itself limited.

It may also be valuable to explore the impact of specific musical ability on the accuracy of AP skills. We were not able to precisely identify the level of skill of each of our participants at their instrument (only classifying them by whether they were grade 5 and above or not) as this is extremely hard to define exactly. Assessing this would have added a lot of time to the survey, making it long and tedious for the participants to complete, which could have reduced the number of responses we received. A future, longer experiment could be undertaken where each participant's level of musical ability is defined according to the Goldsmiths Musical Sophistication Index, and then the results analysed to see if there is a correlation between musical sophistication and accuracy of AP skills.

Another avenue of future research could examine the specific reasons for pianists having better pitch recognition skills overall, or for violinists having such disparate scores between the violin and piano extracts. Although violinists scored much higher than pianists when hearing extracts on their own instrument, pianists scored a higher percentage of correct answers overall as the violinists scored very poorly when hearing piano extracts which lowered their average score. A true experiment could be carried out to determine the reasons for this. A possible explanation is that the piano's pitch and intonation is much more constant than that of the violin; if a piano is properly tuned, then there is no opportunity for the player's sense of pitch to be disturbed by microtonal discrepancies and subtle inaccuracies of tuning. Therefore, a pianist's ability to gauge pitch is strong in relation to both the piano and violin extracts. A violinist, however, has to listen intensely to the pitch of their instrument as they play, so it is possible that over time they are able to internalise specific pitches, such as those at the beginning of famous solos or open strings, but cannot apply this skill to pitches that have no real meaning to them. Additionally, the violinists may have performed more strongly when hearing the instrument they play themselves as a result of timbral factors – the specific timbre of the violin may result in violinists being able to keenly recognise certain pitches on the violin, perhaps as they resonate in a certain manner, whereas the more neutral timbre of the piano means pianists are equally able to apply the skills of pitch recognition to both instruments. This does lead to questions over whether participants are using timbral or pitch factors to decide on their responses. In order to clarify which of these factors influences participants' responses more the experiment could be repeated and altered so that the melody alone from famous violin classical solos is played on a different instrument, potentially the piano to eliminate fluctuations in intonation, in order to observe if the violinists can still identify the correct pitch as accurately without the timbral cues. To make the experiment fair to all participants, extracts could be taken from two orchestral instruments, perhaps violin and clarinet (rather than using pianists as part of the sample group as they may be at an advantage), to observe if the ambiguous and continuous nature of tuning on a string instrument leads to better or weaker pitch recognition than that of wind instruments where the pitches are more static and harder to slide between.

To conclude, musicians who do not possess overt AP are still able to perform above chance levels in pitch recognition tasks using meaningful stimuli. Additionally, the results are further improved when hearing extracts performed on an instrument they play themselves, though the reasons for this are not yet established.

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