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Untangling Musical Intuition: Is Absolute Pitch an Aid in Recognising Musical Form?

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ABSTRACT

The theory of sonata form has been widely discussed by both theorists and aestheticians. This experiment brings a scientific and experimental framework to this discussion and explores the psychological relevance of the theories proposed. Our study focuses on musicians' sensitivity to musical form and the potential advantages of the phenomenon of absolute pitch on this, expanding on Granot and Jacoby's 2011 paper '*Musically puzzling I: Sensitivity to overall structure in the sonata form?*'. We hypothesised that musicians with absolute pitch would achieve a greater degree of accuracy in the identification of musical form. Fourteen participants, seven with absolute pitch and seven without, were given fourteen disordered segments of a Beethoven piano sonata and asked to put them in the most logical order within a set timeframe. The results showed that absolute pitch has a positive impact on the accuracy and recognition of the overall form with the absolute pitch participants achieving better results on average than those without. Previous studies have implied that listeners are more sensitive to the smaller, local harmonic movements within a piece - Levinson's theory of concatenationism. However, our results also imply a sensitivity to the global harmonic structure, which is more suggestive of Kivy's architectonicism.

1. INTRODUCTION

In 2011, Granot and Jacoby published their paper '*Musically puzzling I: Sensitivity to overall structure in the sonata form?'*; the experiment studies the listener's level of sensitivity towards tonal structures in a piece of music. This paper was an expansion on a paper by Bigand & Poulin-Charronnat (2006) which showed that Western listeners, no matter their musical training, had an innate awareness of the harmonic and tonal structures in a tonal piece on a local level, supporting Levison's theory of concatenationism. Granot and Jacoby extended this study by questioning whether listeners could detect the tonal relationships between sections in sonata form: the "most directional musical form" (Granot & Jacoby, 2011, p. 365). In their first study, they divided the first movement of a Mozart piano sonata into ten audio segments and the participants were asked to put them in what they thought to be the most logical order. In the second study, the same method was used, but with a Haydn piano sonata and a different group of participants. Overall, out of the 87 participants (a mixture of musicians and non-musicians), only two correctly completed the task. It is notable that both of these participants were highly trained musicians and one had absolute pitch. However, many participants identified some form of ternary structure built around an unstable B section. They correctly grouped and placed the development sections, although Granot and Jacoby did note that this could be related to the "listener's sensitivity to musical tension" (Granot & Jacoby, 2011, p. 365). Finally, the participants showed sensitivity to opening and closing patterns and recurring themes between sections. Crucially, participants as a whole were shown to have no sensitivity towards the global harmonic structure, which supports the idea of "concatenationism", postulated by Levinson (1997). Ultimately, concatenationism 'emphasizes the moment-by-moment character of musical listeners' basic musical understanding' (Huovinen, 2013, p.1). This view alludes to the notion that the comprehension of musical listening exists in the moment, hence, comprehension of overall form is limited. It must ultimately be established whether form can be considered as the *development* of ideas *through* time, or as the *arrangement* of ideas *in* time; fundamentally, architectonicism is supported by the former notion, and concatenationism by the second.

In our experiment, an attempt is made to further this research by considering whether musicians with absolute pitch have a better comprehension of the tonal relationships between sections in sonata form and can then more accurately perceive the musical form. Absolute pitch is defined as the ability 'either to identify the chroma (pitch class) of any isolated tone' or 'to reproduce a specified chroma… without reference to an external standard' according to the Grove Music Online article on absolute pitch (Parncutt & Levitin, 2001, p.1). We used this definition as a standard for finding suitable absolute pitch candidates. We also decided to limit our sample of participants to musicians to reduce one of our variables, as well as observing if musicians by themselves produced differing results compared to the papers who used musicians and non-musicians.

In 1998, geneticists Baharloo et al. published a report claiming that to acquire absolute pitch, early music training and a genetic pre-disposition were required. As nearly all the participants with absolute pitch had begun formal music training before the age of six, their results also suggested a critical brain development period for acquiring absolute pitch (Baharloo et al. 1998).

However, in 2014, Sakakibara conducted a study in which he successfully taught absolute pitch to 24 children between the ages of two and six using Eguchi's Chord Identification Method (Eguchi, 1991). His results suggested that children younger than six can obtain absolute pitch through intentional training and, as it could not be assumed that all 24 participants were gifted, the explanation that absolute pitch is a result of special talent or genetics could be rejected (Sakakibara, 2014).

Table 1. A Brief Structural and Harmonic Analysis of the Piece and the Final Order of the Audio Tracks

Function in Sonata Form *bar numbers*	Track number *duration*	Overall Track Harmony		Identifying Features of the Track
Exposition: 1st subject	10	I	C	Opening gesture.
b. 1-12	*00:21*			
Exposition: Transition	3	I	C	Modulation to dominant, new arpeggio pattern.
b. 13-26	*00:21*			
Exposition: 2nd subject (a)	12	v	g	New material over alberti bass in dominant minor.
b. 27-44	*00:28*			
Exposition: 2nd subject (b)	5	V	G	More new material, now in dominant major. Transition material returns ending with perfect authentic cadence in dominant.
b. 45-77	*00:57*			
Exposition: Codetta	8	V	G	Based on opening material, many cadential gestures.
b. 77-90	*00:24*			
Development: Pre-core	7	V → V/V	G → D	Same motif as codetta followed by new arpeggio pattern as modulates
b. 90-108	*00:34*			
Development: Core	9	V/V	D	Similar material to opening but in V/V.
b. 109-128	*00:33*			
Development: Retransition	4	V	G	Dominant pedal under melody derived from opening.
b. 129-138	*00:17*			
Recapitulation: 1st subject	13	I	C	Shorter version of opening, ending on I instead of V.
b. 139-146	*00:14*			
Recapitulation: Transition	1	V	G	New material at start but ends identically to exposition transition.
b. 147-160	*00:21*			
Recapitulation: 2nd subject (a)	14	i	c	Same as in the exposition but in tonic minor.
b. 161-178	*00:29*			
Recapitulation: 2nd subject (b)	11	I	C	Same as in the exposition but in the tonic major.
b. 179-211	*00:56*			
Coda: to cadenza	2	I	C	Starts with opening gesture but quickly deviates, ends with a cadenza.
b. 211-232	*01:10*			
Coda: after cadenza	6	I	C	Opening material again combined with multiple cadential gestures.
b. 233-257	00:42			

Levitin deduced that 'absolute pitch is a cognitive ability that relies on self-referencing (to an internalized pitch template), and a highly developed coding mechanism that links verbal labels with abstract representations of perceptual input' (Levitin, 1999, p.1). In our experiment, we predicted that participants who could reference heard notes to an internalized pitch template would have an advantage. For those with absolute pitch, predicting the following note of a segment (and therefore the beginning of the next segment) would be less of an educated guess and more of a factually informed process, speeding up the process of completing the puzzle and allowing them to do so to a more accurate level. This was the main reason that we hypothesised that musicians with absolute pitch would achieve a greater degree of accuracy in the identification of musical form.

2. METHOD

Participants. Fourteen participants (6 females, 8 males; 7 with absolute pitch, 7 without; aged 19-32) who were all musically trained took part in the study. Musically trained in this study meant they actively took part in a high-level musical group frequently and were familiar with the concept of sonata form. Some had more knowledge of music theory than others ranging from ABRSM Grade 5 theory to third year music undergraduate studying analysis. As absolute pitch is such a rare phenomenon, we had to make sure there were enough candidates in the local area who were willing to take part before we went ahead with the experiment. Once we had established there were, we invited them to take part and an advert was sent out to high-level

musical groups to acquire an equal number of participants without. Eight participants were music students and the other six came from a range of subjects. None of the participants recognised the test piece.

Musical stimuli. Table 1 (A brief structural and harmonic analysis of the piece and the final order of the audio tracks) presents the structure and harmonic movement of the 1st movement of Piano Sonata Op. 2 No. 3 in C major by Beethoven in sonata form. The table labels the segments according to traditional musical analysis

of sonata form (which we used as a base for creating the individual tracks) including Caplin's three-part development model, differing to Granot and Jacoby's two-part development (Caplin, 2013). The sonata was chosen as it is dedicated to Haydn and as such is Classical in essence and has a far more orthodox structure compared with some of Beethoven's later works. It also has a very recognisable main motif. This appears throughout the piece and was useful for looking at the identification of important thematic material. We did note that it was difficult to distinguish between the beginning of the recapitulation and the beginning of the exposition as they were so similar, but we chose to not shorten or edit the segments in any way. Instead, we allowed for this disparity in the marking system.

We used *Audacity* to edit the recording, performed by Angela Hewitt (Hyperion Records CDA67605 'Beethoven Piano Sonatas Op. 2/3, 13 & 28'). The total duration of the recording without the repeat of the exposition is 7'47 and the recording was not manipulated (no fade in or out) in anyway apart from the cutting of segments.

Task. The participants were first asked to fill in a short questionnaire regarding their age, gender, weekly listening habits, level of analytical musical training and absolute pitch abilities. They were then sat down at a computer and shown a file of fourteen audio segments of a piano sonata and given 40 minutes to put them in the most logical order and write it down on the form in front of them. The participants also were encouraged to write down their workings on the back of the paper so we could investigate the different methods applied. The segments were put into an order using a random number generator and checks were made to ensure similar segments were not next to each other. Each participant received the segments in the same order and could listen to each track as many times as they wished within the allotted time. In contrast to the original study, we decided to implement a time frame to our experiment (1 hour in total); letting participants take away the experiment increased the likelihood of cheating or discussion between participants. Furthermore, since our study was based on voluntary participation we wanted to ensure that volunteers were aware of the time commitment. At the end of the main task, we interviewed them on how difficult they found the task and how they approached it.

3. ANALYSIS

For our experiment we decided to differ from Granot and Jacoby's 'Distance-score' analysis, which looked at how similar a participant's results were to the correct answer, in favour of a method which allowed for correct groups of segments, regardless of their position within the overall structure (Granot and Jacoby, 2011). Each set of results was marked out of 17: two points for every pair of segments that were correct, a point each for the beginning and closing segments (for recognition of opening and closing gestures) and a point for every completed section (exposition, development and recapitulation). The mark was then turned into a percentage. Awarding points for pairings (or larger groups) of segments allowed us to look at the participants' recognition of local harmonic movement and the interplay of the melodies between segments. Another mark out of 14 was awarded for the overall harmonic movement of each participant. The piece is predominately in the tonic or the dominant, with most of the dominant segments together in-between groups of tonic segments. If we count the segment in the supertonic as part of the dominant section, it is possible to mark each answer out of 14, detracting a point for every dominant segment that strays from the central section. The correct answer is not perfect and scores 13/14, however, it still clearly shows the tonic-dominant-tonic (I-V-I) movement of sonata movement and gaining data this way allowed us to evaluate the participants' sense of global harmonic movement.

4. RESULTS

Overall results. Figure 1 (Average percentage accuracy comparison of all categories) displays a clear trend. The higher absolute pitch scores indicate the advantage absolute pitch has in the recognition of harmonic and tonal structure; supporting our main hypothesis that musicians with absolute pitch would achieve a greater degree of accuracy in the identification of musical form. The rest of the results will focus of the individual aspects of this graph.

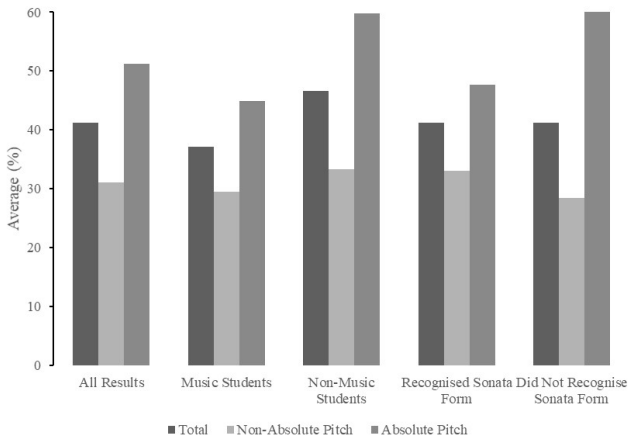

Figure 1. Average percentage accuracy comparison of all categories

Absolute vs non-absolute pitch. Table 2 (Standard deviation of pitch abilities) shows the range and standard deviation of each set of results. The large deviation in both groups validated our results, despite our small sample, and allowed us to continue our study with no changes or additions.

Table 2. Standard Deviation of Pitch Abilities

	Range	Standard Deviation
All Results	50.00	14.64
Non-absolute Pitch	32.35	8.63
Absolute Pitch	38.24	12.35

Figure 2 (Average percentage accuracy comparison of pitch abilities) is a comparison of the percentage accuracy between those with absolute pitch and those without (each participants' mark having been turned into a percentage) and is at the core of our results. The results ranged from 14% - 64% with none of the participants without absolute pitch achieving a mark above 50%.

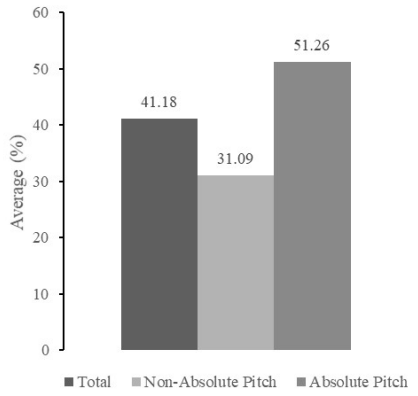

Figure 2. Average percentage accuracy comparison of pitch abilities

Music students vs. non-music students. Not at all the participants were music students (8 music students, 6 other) although all participants had at least ABRSM Grade 5 theory to contribute to their formal musical training. We hypothesised that the music students, having studied the techniques used to split up the original piece, would obtain higher marks. However, this was not the case (see Figure 3 (Average percentage accuracy comparison of music and non-music students)). The clear advantage of absolute pitch is also visible on this graph.

Recognition of sonata form. During our interview, we asked the participants what form they thought the piece was in. Nine correctly identified sonata form and five did not. However, during discussion we found all participants were familiar with the concept of sonata form. We hypothesised that those who recognised sonata form would achieve a higher mark but, again, this was not the case. Once again, the advantage of absolute pitch is clearly visible (see Figure 4 (Average percentage accuracy comparison of recognition of sonata form)).

Global harmonic recognition. Granot and Jacoby (2011) proposed that there was no global harmonic comprehension demonstrated by their participants. However, our results show the capacity of all our participants to create a I-V-I movement within

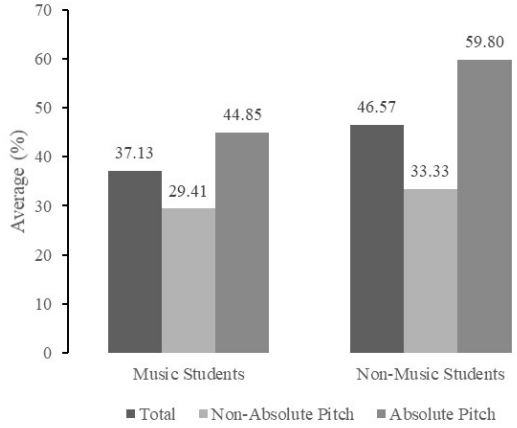

Figure 3. Average percentage accuracy comparison of music and non-music students

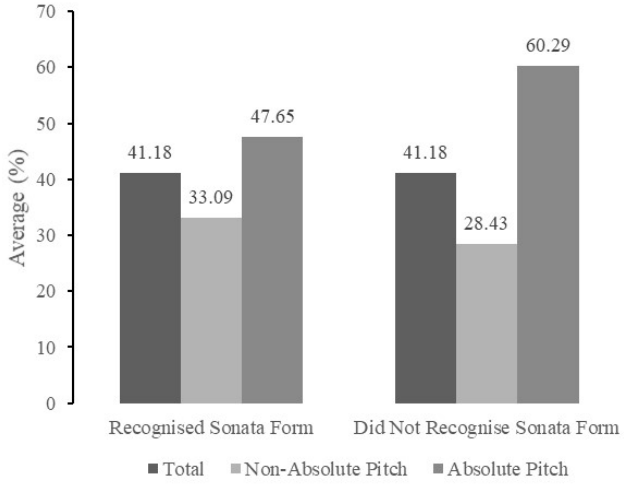

Figure 4. Average percentage accuracy comparison of recognition of sonata form

their results on a subconscious level, demonstrating an instinctive comprehension of the global harmonic ternary structure independent of the physical form, as shown by Figure 5 (Average percentage comparison of I-V-I movement within all categories). Even the poorest performing participants who struggled to pair any segments together or identify opening and closing gestures still achieved a I-V-I movement accuracy above 50%. The clear advantage that absolute pitch had over the other results almost vanishes on Figure 5 (Average percentage comparison of I-V-I movement within all categories) as all the different factors we applied earlier now give very similar results.

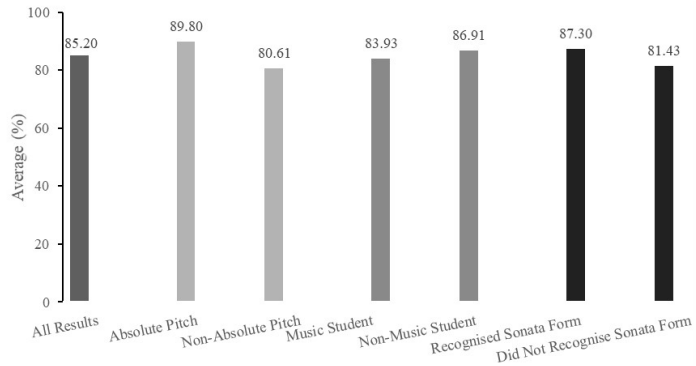

Figure 5. Average percentage comparison of I-V-I movement within all categories

Thematic identification. Over half the participants recognised the main motif, shown by their choice of opening segment. Three participants correctly identified the beginning segment and a further five began with the start of the recapitulation (scoring a half mark). Only two participants did not identify the ending segment and neither of them had absolute pitch. These results correspond with Granot and Jacoby's 2011 study, which also showed a sensitivity to opening and closing gestures.

We also did further study into the different methods of the participants and the recognition of larger sections and the segment order within them, but, found these results to be non-vital to the conclusion of our main research question. Our findings can be found in the Appendix at the end of this paper.

5. DISCUSSION

Compared to Granot and Jacoby's 2011 study, our participants performed well on average, despite no one solving the entire puzzle. On many levels, our results are congruent with Granot and Jacoby's but do differ from all previous studies when it comes to the perception of global harmonic structure. We will first discuss our results and then expand on why differences may have occurred.

Our results support our hypothesis, that people with absolute pitch achieved a greater level of accuracy in identifying musical form, although being able to recognise sonata form by name did not appear to give any advantage to the participants. Similarly, no advantage can be inferred for the level of formal music theory training that each participant received, especially as the music students we studied did worse, on average, than those studying other subjects - although it is important to highlight once again that all the participants are musicians performing at a high level within the University, independent of their degree. Our results also agree with those of Granot and Jacoby in that overall, our participants showed sensitivity to opening and closing material and shared thematic material between sections. However, and most notably, our results contradict previous studies in that all our participants showed a comprehension of a global harmonic structure, shown in the clear I-V-I movement found in all participants' answers, even when the actual percentage accuracy was very low. This disparity may be due to the fact that we only used trained musicians who take part in many musical activities per week and consequently have come across this harmonic structure so many times it has become ingrained in their memories. As our results for the global harmonic structure are consistent across all our different categories and variables (music students, absolute pitch abilities, correct recognition of the overall form), we believe that our contradictory results are unlikely to be an anomaly and suggest that further research into the perception of global harmonic structure should take place.

Looking at these results from a psychological point of view, the clear sensitivity of our participants to the global schemata points away from concatenationism (Levinson, 1997) and towards Kivy's notion of architectonicism (Kivy, 2001). This concept asserts that listener do not hear a piece of music as momentary time fragments, but rather as an overall journey on a larger scale. Whilst Levinson champions the idea that listeners cannot comprehend a larger global journey within a piece of music, an idea that is backed by the results of Granot and Jacoby (Granot & Jacoby 2011, 367), our results indicate that this is not the case. The ability to identify the tonal journey of the work through the 'jigsaw-puzzle methodology' suggests that there is in fact a listening experience on greater scale than suggested by Levinson. Since the participants with absolute pitch achieved slightly better results in the overall comprehension of the form, it could be argued that greater architectonic tendencies are present in those with absolute pitch. However, since the difference between the results of the two groups was rather narrow, it is far more likely that musical training holds a greater bearing on this. This may explain the differing results in Granot and Jacoby's results, where a mixture of musicians and non-musicians were used in the study. Therefore, we postulate that it is possible to see these two concepts on a scale, rather than as in dichotomised opposition; where the level of formal musical training affects the extent to which an individual experiences architectonicism as opposed to concatenationism. Perhaps musicians are more drawn to the overarching structure architectonicism claims, their ear trained to hear thematic development and recognise the pull of musical tension in the centre of a movement before the needed resolution signals a return to the tonic. On the other hand, non-musicians may be more focused on the music they hear in the moment (Levison's concatenationism) and are not trained to listen to the piece as a coherent whole to the same level of intensity and detail. The non-musician is more likely to perceive music as an arrangement of ideas in time, with less sensitivity towards developmental ideas within a piece.

The main shortcoming of our experiment is that our sample of participants is small and, therefore, potentially limited in its accuracy. Due to the rare nature of absolute pitch we had to find enough participants before we could go ahead with planning our experiment. However, since the range of results we received and

the standard deviation of our main results (absolute pitch vs non-absolute pitch average correctness) was quite large, we established that we had a sufficient range of data for our results to be viable. In addition, the introduction of a time limit meant that it was not a direct replication of the original study but had the advantage of meaning that the task was addressed equally by all participants.

A further study could directly compare musicians' and non-musicians' sensitivity to form, to see if musicians do have an instinctive grasp of musical form and compare the respective party's understanding of global harmonic structure. The experiment could also be repeated with a non-tonal work, once again comparing musicians with and without absolute pitch to see if participants with absolute pitch still have an advantage. Another study could compare the role of a musicians' primary instrument on the comprehension of overall form and another on the influence of certain cues within each segment on their order, looking at register, thematic material and melody.

Overall, it is clear to see that the results from this study provide five clear findings: i) the possession of absolute pitch improved accuracy in identifying musical form, ii) knowledge that the piece was in sonata form did not give any clear advantage, iii) the level of musical training of the participant did not give any clear advantage, iv) participants showed strong sensitivity towards opening and closing gestures, and v) all participants were able to demonstrate a clear comprehension of global harmonic structure.

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APPENDIX

Recognition of the development.

When marking each participants' results, there was a maximum of three marks available for each complete section (exposition, development and recapitulation). However, the only section that was found in a near or fully completed form was the development. This was expected as in Granot and Jacoby's paper, they stated that they had observed the correct placement of developmental sections. However, Granot and Jacoby's development was made up of only two sections whereas we split the development according to Caplin's three-part model. Looking into this further, we marked the development out of three, with a complete section achieving full marks, and one mark given if there were two sections grouped together in the wrong order.

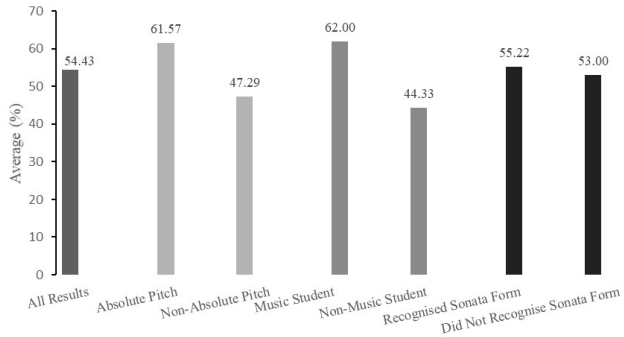

Figure 6. Average percentage comparison of development recognition within all categories

In Figure 6 (Average Percentage Comparison of Development Recognition Within All Categories), we see that participants with absolute pitch showed better sensitivity when grouping this section together correctly compared with those without. The development is the only section that includes segments that aren't in I or V. Therefore, the modulation from G to D major in the pre-core of the development, followed by the core in D major may have been easier to find and identify as a correct pairing for those with absolute pitch. The music students also showed more sensitivity compared to non-music students, which could be due to a more in-depth knowledge of the form. However, looking at the comparison of those who did and did not recognise sonata form, these results suggest that having a more in-depth knowledge is not the reason the music students performed better at this task. These results possibly indicate an innate and subconscious recognition of the theories posed by Caplin, regarding the sections in the development, giving emphatic evidence to support this theory.

Strategies of the participants.

During our interviews of the participants, we found various strategies with which they approached the task. There were two main strategies of approaching the task and three sub-strategies.

Main strategies:

1) Choose a start and an end segment
2) Focus on linking individual segments

Table 2. Strategies of the Participants

Strategy used	Percentage Accuracy (%)	Number of participants	Participants with Absolute Pitch	Participants without Absolute Pitch
1	43.53	5	2	3
2	43.28	7	4	3

Participants with absolute pitch showed a slight preference for 2, whereas those without showed no preference. However, neither strategy gave an advantage, both giving a near identical average. Two participants used neither method.

Sub-strategies:

i) Group into three sections (either the beginning, middle and end, or labelling them as their formal titles within sonata form)
ii) Predict what comes next and find a fitting segment
iii) Work in a straight line towards a set point, either working forwards from the beginning or work backwards from the end.

Table 3. Sub-strategies of the Participants

Sub-strategy used	Percentage Accuracy (%)	Number of participants	Participants with Absolute Pitch	Participants without Absolute Pitch
i	49.26	4	2	2
ii	47.48	8	5	2
iii	48.53	2	1	1

Once again, each strategy gave a very similar average, despite the absolute pitch preference for sub-strategy ii. Two participants used two sub-strategies and two used no sub-strategy.

While the different strategies presented were interesting to study, no one strategy proved to be more successful than any other. The preference of participants with absolute pitch on strategies that focused on linking individual segments and predicting what could come next could be due to them being able to clearly name the keys and therefore the relationship between them. However, more research needs to be done to confirm if this assumption is correct.