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# Engagement and Visual Imagery in Music Listening: An Exploratory Study

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The following study will be part of the first author's Performance PhD Thesis upon completion (the course was funded as part the University of Hull's scholarship programme). Aspects of the following research have been presented in the form of preliminary results in some conferences; however, with exception of the conference papers' abstract, none of the findings included in this manuscript have been published elsewhere.

## Abstract

This exploratory study empirically investigated music listeners' responses to solo piano works with respect to their levels of musical engagement (heightened attention and interest towards the music; Olsen, Dean & Stevens, 2014) and their experience of music-induced visual imagery. Although engagement and visual imagery have been increasingly explored over the past two decades, little work has investigated the relationship between the two. Potential links exist, since visual imagery has been described as one of the key mechanisms underlying listeners' emotional responses to music. Thirty-four participants listened to four complete piano works and used a slider to continuously provide self-report measures of their engagement with the music and the occurrence of visual imagery while listening. Time series analyses revealed that engagement with the music was significantly associated with visual imagery experience. Granger causality tests were carried out to investigate the details of the nature of this relationship. Overall, engagement mostly predicted visual imagery, but differences by piece and musical experience are apparent. Individual differences are reported with respect to engagement and visual imagery responses.


*Keywords*: Music Listening, Visual Imagery, Engagement, Continuous Responses

# Engagement and Visual Imagery in Music Listening: An Exploratory Study

There are times at which music entirely occupies a listener's attention; at others, music can be described as ‘sound wallpaper’ (Gabrielsson, 2011:2): a listener's real-time engagement may fluctuate across the spectrum between these two extremes. Engagement can be associated with heightened attention and interest (Olsen, Dean & Stevens, 2014) and is described as a multidimensional and multifaceted construct (Schubert, Vincs & Stevens, 2013)—one's engagement is likely to be linked to other aspects of the listening experience, such as enjoyment or familiarity. Among the numerous personal and cultural factors that can come into play as to what engages us in a piece of music, existing research has proposed various links with emotion. For instance, a listener's engagement seems to serve as a mediator to perceived affective responses in music (Olsen, Dean & Stevens, 2014), and is considered an important component to listeners' enjoyment of a performance (Thompson, 2007). The way engagement can relate to emotional experiences also emerged in Gabrielsson's (2011) *Strong Experiences in Music* (SEMs): sometimes described as peak experiences, SEMs typically involve highly emotional events in which a listener may be totally absorbed with the music. Considering the way visual imagery in music listening has been increasingly associated with emotions over recent years (Juslin & Västfjäll, 2008; Balteş & Miu, 2014; Vuoskoski & Eerola, 2015), it is perhaps not surprising to find a dedicated section on ‘Inner Images’ also within Gabrielsson's (2011) work. Numerous qualitative accounts report music listeners being ‘spellbound’ and absorbed in the music, as a rich variety of multimodal imagery is experienced. For many, the experience of visual imagery is recognized as a common phenomenon: ‘it seems that as listeners receive music, they often associate it with beliefs, sentiments and images’ and ‘may characterize a musical work somewhat programmatically’ (Campbell, 1998:174). Yet, if listeners *may* experience imagery, under what circumstances could that be the case? In other words, *what contributes to the experience of visual imagery in music listening*? The term ‘mental image’ refers to the presence of a representation of the type produced during the initial phases of perception but without the stimulus being actually perceived (Kosslyn, Thompson & Ganis, 2006:4). An interest in visual imagery in

response to music has gained ground from a variety of approaches in the past two decades (Tavernaro, 2016; Küssner & Eerola, 2017; Balteş & Miu, 2014). For example, process theories describe visual imagery as a key mechanism underlying listeners' emotional responses during music listening (Juslin et al., 2010), potentially revealing a link between music-induced visual imagery and engagement with the music. Very little research attention has been paid to the relationship between engagement and spontaneous visual imagery during music listening; the following study attempts to address this research gap, investigating the possible link through the analysis of continuous self-report responses to ecologically valid musical material.

## Visual imagery

Mental imagery has an important role in our everyday lives. The way imagery is tied to thought and introspection, the process of 'looking within', suggests that imagery is important to problem solving, memory, creativity, emotion and even language comprehension (Kosslyn, Thompson & Ganis, 2006:4). The broader definition of imagery does not limit itself to the visual modality: Richardson (1969) referred to mental imagery in relation to 'all those quasi-sensory or quasi-perceptual experiences' (pp.2-3) which include any sensory, perceptual, affective or other experiential states, such as hunger or fatigue. Imagery may therefore be perceived across a varied range of sensory modalities—these are generally described as visual, auditory, kinaesthetic, tactile-temperature, olfactory, gustatory imagery and organic (feelings and bodily sensations, such as thirst)—and not necessarily in a unisensorial manner: one type of imagery may also influence imagery or perception in another modality (Lacey & Lawson, 2013). However, the following study will focus on the visual modality. Visual imagery is commonly described as 'seeing with the mind's eye'; indeed a suitable definition, considering that neuroimaging studies such as Ganis, Thompson and Kosslyn (2004) showed that the brain regions employed by visual perception and visual imagery overlap by more than 90%.

The largest body of research exploring visual imagery in music listening lies predominantly within the therapeutic domain. The music-imagery combination emerged as a powerful therapeutic

tool, and has been shown to promote positive psychological and physiological health outcomes in adults (McKinney & Honig, 2017). A particularly prominent practice in the field is Helen Bonny's *Guided Imagery and Music* (Bonny & Savery, 1973), a method of psychotherapy whereby clients are invited to share their images as imaginary travellers as they listen through a carefully programmed musical sequence (Goldberg, 1995), specially tailored around specific therapeutic goals. Therapeutic practices and various studies acknowledge music as an effective facilitator in the experience of visual imagery (Quittner & Glueckauf, 1983; Band, 1996; Osborne, 1981). Music also appears to enhance aspects of the imagery experience, such as increased vividness, as well as increased absorption levels—based on self-reported, single ratings (Band, 1996). Yet, listeners' individual differences also seem to bear an influence. In a study by McKinney and Tims (1995), the high imagers group imagined more vividly and more actively than low imagers, although the study was not confined to the visual modality. Imagery abilities also emerged as a significant factor in Balteş and Miu's (2014) study investigating emotions during a live opera performance of Puccini's Madame Butterfly: participants with a higher inclination towards experiencing more vivid visual imagery, as measured using the *Vividness of Visual Imagery Questionnaire* (Marks, 1973), experienced more unease and chills in the opera's second act—a moment at which sadness or tensions are likely to relate more to the particularly evocative lyrics than the events taking place on stage. Visual imagery also appears to be associated with increased enjoyment from listeners. Zalanowski (1986) investigated the effects of listening instructions on music appreciation; the ‘free formation of mental images’ task resulted in significantly greater enjoyment ratings, as opposed to the ‘pay attention’ or ‘follow a story from a given programme’ task. Similar findings emerged in Lewis (2012), where students with a greater tendency to experience visual imagery during music listening had greater liking for the music.

At times, research concerning visual imagery focuses on very specific, confined aspects of the listening experience. Examples include investigations of the associations between specific sounds and their imagined visual equivalent, for instance, such as Eitan and Granot's (2004) imagined body motions to brief, tonally ambiguous sound stimuli. Nonetheless, the recent, renewed

interest in the field has given rise to new approaches and broader explorations of the subject. Küssner and Eerola (2017) investigated the prevalence and nature of visual imagery in 146 music listeners through an online survey (also discussed later). 66.44% of participants reported experiencing visual imagery during music listening, with only 6.16% reporting never experiencing visual imagery when listening to music (27.40% did not respond). The study reported three factors which emerged from participants' descriptions of visual imagery to music listening, accounting for 62% of the variance: realistic imagery (real-world scenes such as landscapes or people), abstract imagery (such as abstract shapes or colours) and absorbing imagery (relating to absorption or relaxation states; e.g. 'the images... make me feel calm'). A small positive significant correlation was present between the VVIQ with the realistic imagery as well as the absorbing imagery, but not the abstract imagery factor. A number of studies have also investigated the way in which the presence of dramaturgic details can impact listeners' perceptions of the musical works (Vuososki & Eerola, 2015; Landy, 2006), providing the 'something to hold onto factor' (Landy, 2006). The following study, however, aims to explore a more spontaneous use of visual imagery during music listening.

**Engagement**

'Engagement' has been variously defined, reflecting different understandings. For example, to 'engage with' is defined as the establishment of a meaningful contact or connection, occupying or attracting someone's attention (Oxford Dictionary). In work exploring children's classroom engagement and performance, Furrer and Skinner (2003) define engagement as 'active, goal-directed, flexible, constructive, persistent, focused interactions with the social and physical environments' (p.149). A great amount of educational literature refers to engagement as a multifaceted construct embracing affective, behavioural and cognitive dimensions (Fredricks, Blumenfeld & Paris, 2004). Behavioural engagement includes effort, attention and concentration; emotional engagement includes interest, enjoyment and enthusiasm; cognitive engagement incorporates motivation, strategy use and effort (Skinner et al., 2008; Fredricks, Blumenfeld & Paris, 2004). In music research, engagement is less commonly partitioned into the components explored in

educational studies—only occasionally, studies may refer specifically to *emotional engagement* by means of emotional responses to music (as in Timmers et al., 2006). Numerous studies interpret music engagement as the active involvement of music related activities in our everyday, cultural habits. Examples include the frequency of musical activities undertaken (Wöllner et al., 2011), trends in musical preferences and listening habits (Upadhyay, 2013; Bolden & Nahachewsky, 2014) or behavioural reactions to music listening (de Vries, 2011). However, other empirical studies refer to music engagement more closely related to the specific instance of music listening. Studies such as Lamont (2011) and Olsen, Dean and Stevens (2014) describe engagement as the induction of *flow*, or absorption: a state of mind 'in the zone' and fully immersed in the performance of a particular activity or task. More importantly, it is pointed out that this concept of engagement is not necessarily linked to a positive experience. It is the latter definition that will be of central concern in the following study: the feeling of being compelled, drawn into what is happening in the music and interested in what will happen next (Schubert, Vincs & Stevens, 2013).

**Visual Imagery and Engagement: The Potential for Common Ground**

A variety of research aspects seem to implicitly point towards a potential imagery-engagement connection; yet, to date, literature empirically exploring possible links between engagement and visual imagery in music listening is scant. An exception to this is the work by Tavernaro (2016). 140 participants listened to nine orchestral clips (40 seconds in duration) from 19$^{th}$ and 20$^{th}$ century instrumental works under three different experimental conditions: 1) provided with a text description seemingly congruent with the excerpts, 2) provided with an incongruent description, and 3) with no prime. When a text was provided, participants were asked to imagine the given description while listening to the music. Following the listening tasks, participants were asked to state whether visual imagery occurred, as well as to provide on a 7-point Likert-type scale the vividness of their imagery and time spent imagining. All participants were also asked how engaged they were with the music, their enjoyment levels and their emotional reaction. While most music listeners reported visual imagery, participants in the congruent conditions were significantly more

likely to experience visual imagery than the other two conditions. Furthermore, when imagery was experienced, listeners reported enhanced engagement, higher enjoyment levels and stronger emotional responses to the music.

## The Underlying Emotional Response in Music Listening

According to Juslin et al.'s (2013) BRECVEMA theoretical model, amongst the eight ways in which music can elicit emotions we find visual imagery (other proposed mechanisms are *Brain stem reflex*, *Rhythmic entrainment*, *Evaluative conditioning*, *Contagion*, *Episodic memory, Musical expectancy* and *Aesthetic Judgement*). This framework refers to visual imagery as a process in which an emotion is induced in a listener as a result of the close music-imagery interaction. Listeners seem 'to conceptualize the musical structure through a metaphorical non-verbal mapping between the music and 'image schemata' grounded in bodily experience' (Juslin et al., 2010:622; see Lakoff & Johnson, 1980). For each of the psychological mechanisms in Juslin et al.'s (2010) model, findings from various disciplines are synthesized into theoretical predictions. According to the model, visual imagery's ontogenic development occurs around children's pre-school years. The mechanism is highly influenced by culture and learning, hence by one's exposure to various musical styles, and may induce all possible emotions. The model also describes visual imagery's induction speed as low, and with a high degree of volitional influence: listeners may influence the imagery process by actively conjuring, manipulating or dismissing mental images (Juslin et al., 2010:623). Further properties of visual imagery include a high availability to consciousness, or high awareness of the induction process (or aspects of it) from listeners; low degrees of independence as a mechanism (low modularity—hence visual imagery's induction process may be potentially activated alongside other psychological processes); and finally, medium dependence on musical structure.

Reflecting on the above properties, particular features stand out as forming a potential link with musical engagement. For instance, the influence of culture is also shared with engagement: what attracts our attention and interest in a piece of music may be influenced by culture-specific, personal factors (Olsen, Dean & Stevens, 2014). While listeners' visual imagery may be connected to

any emotional aspect, engagement can also relate to emotional factors. Examining listeners' affective responses in terms of Russell's (1980) circumplex model (a two-dimensional framework of perceived affect comprising arousal (aroused/calm) and valence (positive/negative)), Olsen, Dean and Stevens (2014) suggest that engagement can play a mediating role in such affective responses by listeners. More specifically, they showed that a continuous measure of engagement levels was a modest but statistically significant predictor in time series models of perceived arousal and valence. This was also mostly the case when other measured acoustic parameters (intensity and spectral flatness) were included in the model.

Returning to other studies supporting a visual imagery-emotion link, the three factors which emerged from listeners' imagery in Küssner and Eerola (2017) (realistic imagery, abstract imagery and absorbing imagery) resulted in a small but statistically significant positive correlation with the 'Sophisticated Emotional Engagement' battery of the *Goldsmiths Musical Sophistication Index* (Müllensiefen et al., 2014). In a study investigating listeners' emotional reactions to music (Juslin et al., 2008), visual imagery appeared fourth in frequency amongst participants' self-reports of believed causes of emotions, representing 7% of the data. This was preceded by episodic memory (14%), brain stem response (25%) and emotional contagion (32%). Whilst the frequency of responses identifying visual imagery as emotion-eliciting is rather low, it may as well be possible for participants' recall of past memories to overlap, to varying degrees, with visual imagery. If visual imagery is characterised by low independence as a mechanism in Juslin's theoretical model, we can expect greater chances for imagery to occur in conjunction with another. For instance, when our emotional response to music is intense (high in arousal, Russell, 1980), this in turn could heighten our engagement with the music and trigger a visual imagery response. Therefore, the potential mediation of visual imagery and engagement by means of a listener's emotional response to music points towards a potential correlation between the two.

It may also be possible that experiencing visual imagery enhances our overall music listening experience through the addition of a further 'visual' dimension. The presence of visual imagery could

increase our engagement with the music as a result of a multimodal form of engagement. Furthermore, if the music we are listening to evokes certain images in our minds, that process of translating sound into images would imply a personal understanding of the music. In this respect, we may relate such understanding to Hargreaves, Hargreaves & North's (2012) work on *Networks of Association*, suggesting that 'listeners create their own personal 'network of association' which acts as reference points for their mental representations of their musical worlds' (Hargreaves, 2012:547).

Finally, other sources seem to further suggest an underlying connection between visual imagery and engagement. The *Absorption in Music Scale* (AIMS) questionnaire (Sandstrom & Russo, 2013) is a 34-item measure of one's ability and willingness to be drawn by the music into an emotional experience. It is interesting to notice how visual imagery has been incorporated in two of its questions: 'when listening to music, I often imagine the musicians playing the songs' (n.28) and 'I sometimes see vivid images in my head when I listen to music' (n.31). This inclusion of imagery implies a connection with being absorbed in the music—hence a high musical engagement. Similarly, from the perspective of dimensions of visual imagery identified by Richardson (1969), 'imagination-imagery' is described as involving a 'concentrated and quasi-hypnotic attention' (p.94).

The current study stems from a larger exploratory project which gathered both quantitative and qualitative data, the latter with the aim of gaining further insight into participants' experiences of visual imagery through written annotations and face-to-face interviews. This paper will, however, focus on the quantitative aspects of the study, which had the following aims:

- To investigate whether links are present between visual imagery and engagement continuous responses during music listening.
- To explore individual differences in engagement and imagery responses.

We hypothesized that ratings of the occurrence of visual imagery would be positively associated with ratings of engagement with the music, as supported by the above discussion. Whilst the second aim was exploratory, recent studies point towards significant correlations between visual imagery experience and aspects of musical skills (Küssner & Eerola, 2017; Tavernaro, 2016). Various

studies suggests an active, frequent use of visual imagery for a variety of music performance practices; from memorization (Holmes, 2005), performance anxiety and relaxation techniques (Bowes, 2009) and motivational support (Clark, Williamon & Aksentijevic, 2012), to metaphorical associations in sound production (Trusheim, 1991; 1987). Research in psychology has contributed to our understanding of perception-action coupling, whereby perceiving sounds is understood in terms of the actions required to perform them (Cox 2001; Godøy 2001). This is argued to be of particular relevance to musicians who may well experience a heightened form of mental imagery when they listen to music with which they have a performative affiliation (Bailes 2019). We therefore hypothesise higher levels of visual imagery being experienced by more musically experienced participants than less musically experienced individuals regardless of its content; whether this involves narrative or visualizations of the score.

## Materials and Method

### Ethics Statement

All participants agreed to take part in the study through written informed consent. The study was approved by the School of Drama, Music and Screen Ethics Committee of the University of Hull on March 4, 2016.

### Participants

Thirty-four participants[1] (16 female) undertook the experiment voluntarily. Ages ranged from 21—72 years, with a mean age of 35.56 (SD = 13.44). Occupations included currently being in higher education (70.59%), full-time or part-time employment (17.65%), self-employed (5.88%) and retired (5.88%). Twenty-three participants had completed a postgraduate degree, two had completed an undergraduate degree or A-Level qualifications and nine cases did not specify any attained qualification. Nationalities were also varied across the group, with 55.88% British and the remaining 44.12% consisting of participants from 14 different countries. No participant reported

[1] A total of 35 participants joined the study, however only data from 34 listeners were utilizable. Data from participants who expressed being 'too engaged with the music to remember to move the slider' were omitted.

experiencing synaesthesia in relation to music listening. In order to investigate the possible effects of music training and expertise, 'more musically experienced' and 'less musically experienced' groups were formed by ranking the Gold-MSI *Musical Training* scores (Müllensiefen et al., 2014)[2]: the top half, comprising the highest scores from 50% of participants, were classified as more musically experienced, whilst the remaining group as less musically experienced—groups which also particularly reflected the current musical status or self-consideration of participants' musical expertise. Further demographic details for each group are displayed in Table 1.

## Materials and Equipment

Four complete pieces of Western solo piano music were performed by the first author on a Yamaha C3 and audio recorded in a Sonic State Logic (SSL) Duality Studio for the purposes of the experiment. Each selection was a composition from the late 19th or early 20th centuries and lasted approximately three minutes in duration. The musical works were selected with the aim of offering a variety of texture, harmonic language, dynamic levels and contrasting musical characters between them, yet maintaining a relatively short duration. Each track began with three silent seconds before the start of the music; this was to allow time for participants to focus on the new track and for the researcher to move away from the equipment area, due to pieces being manually set up before each task. Works from four different composers were selected, presented in Table 2.

Continuous engagement and visual imagery ratings from participants were recorded through the use of a continuous affect rating and media annotation software: CARMA beta v.13.01 (Girard, 2016). A modified version of the original program (Girard, 2014) was used, which integrates the use of a 100mm MIDI slider (I-CubeX Push V1.1) as an input device. This was installed on an Aspire E15 E5-571-39S2 laptop, from which tracks were played at 80 volume units[3]. Participants used KRK Systems KNS-6400 headphones to hear the audio tracks. A view of the listening tasks set-up may be seen in *Figure 1*.

[2] No musical genre restrictions applied, although the large majority of the more musically experienced group was formed by classical musicians.

[3] Only three participants required lower volume levels due to hearing aids or ear sensitivity.

Face-to-face interviews at the final stage of the experimental procedure were audio recorded using a TASCAM DR-05 V2 Portable Digital Recorder; throughout this session, extracts from the audio stimuli were played back as listening-cues through a set of GENELEC 1029 speakers.

The experiment was carried out in an office at the University of Hull campus. To reduce the possibility of visual distractions by participants in the course of the listening tasks, the experimental room was plain and the computer screen back-faced participants' frontal view.[4]

**The use of Continuous Measures**

Studies exploring different aspects of engagement or absorption in music listening often investigated listeners' response through written accounts of their experiences, varying from free retrospective reports (such as Lamont, 2011) to questionnaires and likert-scale ratings (Sandstrom & Russo, 2013; Wöllner, Ginsborg & Williamon, 2011; Tavernaro, 2016). Collectively, such accounts provide important insights into the role of engagement across various listening experiences. Yet, there is only a certain degree of depth that these methods are able to capture, as soon as we take into account the fluctuating nature of the listening experience. It is therefore unsurprising to find an increasing number of studies adopting continuous self-report measures to investigate live responses to music listening. As Timmers et al. (2006) pointed out, although in relation to emotional engagement, 'the use of continuous measurement provides the possibility of zooming in and investigating the relation between music and emotional response locally' (p.482). Studies making use of continuous ratings have adopted a variety of approaches and interface equipment. Often, these involve computer based tasks, where the cursor displayed on the screen is continuously adjusted in relation to a set scale, such as bi-dimensional models. In the context of the following study, the use of a screen could form a visual distraction, potentially interfering with participants' imagery experience. To overcome these issues, the use of a slider was deemed more suitable: this method enables participants to gain a sense of the upper and lower extremes of the rating scale

[4] Participants did not see the computer screen at any time during the listening tasks.

without the need of further visual cues, allowing participants to close their eyes at will whilst the task is being performed.

## Procedure

***Pre-experiment Questionnaires*.** Approximately 48 hours before the agreed meeting, participants were sent via email an electronic questionnaire comprising the *Goldsmiths Musical Sophistication Index* v1.0 (Müllensiefen et al., 2014) and the *Absorption in Music Scale* (Sandstrom & Russo, 2013).

**Listening Tasks.** The experiment took place in an office at a university campus; possible elements of visual distraction were removed from participants' view. In a first task, participants were asked to listen to the four piano pieces and continuously rate either their engagement with the music, or their experienced imagery, as specified by the researcher. The same pieces were then played again in the same order, this time undertaking the alternative listening task not completed previously (engagement or imagery). The order of the tracks was randomized before each experimental session through an online list randomizer [random.org].

In the engagement task, participants were asked to rate continuously with the use of a slider their engagement with the music. The following instructions and definition of engagement were given: "*feeling compelled, drawn in, connected to what is happening in the music, interested in what will happen next* (Schubert, Vincs & Stevens, 2013); *it does not matter whether this is in a positive or a negative way: please rate how immersed you are in what you are listening*". An increase in engagement was indicated by moving the slider vertically upwards (away from participants' body), whilst decreases in engagement were expressed through a downward movement of the slider. The lowest point on the slider implied a minimal engagement with the music.

The second task involved indicating whether at any moment, whilst listening to the music, any visual imagery emerged from the music being played. Participants were given new instructions: "*visual imagery is sometimes described as seeing with the mind's eye. Please indicate whether any images come into your mind from listening to that piece of music*". Once again, the slider was used to

track continuous responses: a rise of the slider indicated the presence and possible strength or vividness of the visual imagery, whilst positioning the slider fully down indicated no imagery being experienced.

The order of presenting each task was counterbalanced across participants. Prior to the main data collection, a short clip was played as a short task trial, to let participants familiarize themselves with the use of the slider (the opening bars from Rachmaninov's *Étude-Tableaux* Op.39 N.2 in A Minor [track length 21″] were used for this).

After each piece, participants completed brief questions on likeability and piece/genre familiarity of the piece heard using a 7-point Likert-type scale. Following the imagery tasks, participants were also asked to provide—if applicable—any annotation to remind them of the imagery experienced, as well as suggesting a possible title for the piece. The order of these questions was arranged in relation to the order of the listening tasks (engagement/imagery).

**Post Listening Questionnaire.** Following the listening tasks, participants completed the *Spontaneous Use of Imagery questionnaire* (Reisberg, Pearson & Kosslyn, 2003), a measure recording individuals' self-rated tendency to use visual imagery in everyday life.

**Interviews.** For those wishing to proceed further, a semi-structured face-to-face interview was then immediately carried out. Overall, 34 participants were interviewed, but data for one interviewee were lost due to a technical problem, leaving a total of 33 interview transcripts for analysis; imagery experiences were discussed with the aid of participants' annotations and the use of listening cues, alongside a display of their continuous responses through CARMA's review function.

The overall experimental procedure lasted approximately one hour. A visual overview of the procedure is presented in *Figure 2*.

## Results

The mean response series (Figures 3–6), provide a sense of salient moments in the music over time with respect to the mean engagement and imagery ratings. Mean values are calculated at every 0.5 second of each piece across the sample group.

## Examples of Response Contexts

### Debussy

The highest point of Debussy's grand mean ratings for visual imagery (see *Figure 3*'s top panel, lighter line, just before 100 seconds), coincides with the music's bars 74–75, displayed in *Figure 7*. In terms of the piece's structure, the following passage emerges from an unexpected twist in the musical material: bar 59 brings a return of the opening theme, which despite a slightly varied left-hand accompaniment and the melodic line shifted up an octave, is nonetheless presented in its original key (F minor); yet, the arpeggiated figures which follow (originally in C major), this time appearing in D-flat major (bar 66), lead into a new elaboration of the musical material (bar 74). Whilst average engagement ratings are also relatively high at this point, the highest level of mean engagement is reached slightly later (see *Figure 3*'s top panel, darker line, around 115 seconds)—although, noticeably, such increase is marginal. This takes place towards the end of the work's central climax (this increase peaks around bars 85–86, *Figure 8*). Similarly, a further rise in engagement ratings emerges towards the end of the piece, the work's final *ff* climax. This suggests that, within the context of the following piece, there was a tendency for slight increases in engagement ratings towards musical climaxes.

### Rachmaninov

The possible coincidence of peak imagery and engagement responses with certain aspects of the music in Debussy, seems to be reversed when looking at the sample's peak responses to Rachmaninov. This time, it is the highest peak in *imagery* ratings (at approximately 105–115 seconds in *Figure 6*) which takes place during the first, small climax of the piece (see Figure 9). As may be observed in *Figure 6*, engagement ratings also present a particular increase in this passage of the music; however, its highest peak is reached at an earlier stage of the music: bars 20–21, the return of the work's initial theme (Figure 10). Therefore, Rachmaninov's musical climax attracted overall higher imagery ratings, and the return of the (by then) familiar, thematic material was rated particularly highly in engagement.

## Tests of the Relationship between Engagement and Imagery

In order to test whether continuous ratings of engagement corresponded with reported occurrences of visual imagery, time series analysis was performed with the use of *R* programming software. The use of time series analysis methods is an essential part in revealing whether such associations are present, since conventional correlation analyses rely on the assumption of independent data points (Bailes & Dean, 2012:363). However, this cannot be the case for data in a time series, since these do not comprise independent values: each point is inevitably related to the preceding and related to the next. An insightful paper by Dean and Dunsmuir (2016) warns against the dangers of the 'unfunded reliance' placed on cross-correlations in analysing time series, which frequently misleads into spurious relationships. For a detailed insight into the analytical procedures involved, Dean and Dunsmuir (2016), as well as Dean and Bailes (2010), provide comprehensive accounts.

A brief outline of the steps involved is provided below, alongside relevant samples of R code `[in Courier New font]` extracted and adapted from Dean and Dunsmuir (2016).

### Time series analysis: procedure and code samples

**1. *Outliers removed from the mean time series***. A grand mean series is produced (for each observed measure) by averaging across participants' series at each sampled time point. Values which exceed + or - 2.5 standard deviations from the overall series mean are replaced by the nearest value from that range.

**2. *Stationarity*.** The series is differenced (hence, a new series is created of the difference values between each data point in the series and its predecessor) using the R code below at lag = 1, until stationarity is achieved, i.e. the mean and variance are constant. Stationarity is tested using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS); a stationarized series' value at a given time should be a predictor of change with a negative coefficient, 'since larger than mean values tend to be followed by smaller ones and vice versa' for the next value to be closer to the mean (Dean & Bailes, 2010:156).

Codes example:

```
kpss.test(rac_mus_imag)       #KPSS stationarity test. If significant, the
                              #series is not stationary.

d1imagery <- diff(rac_mus_imag, lag=1)    #First-differencing the original
                                          #series.
d2imagery <- diff(d1imagery, lag=1)       #Second-differencing the series
                                          #(when required to achieve
                                          #stationarity of the series, as
                                          #indicated by the KPSS test: a
                                          #significant p-value indicates
                                          #a non-stationary series).
```

**3. *Pre-whitening*.** Whilst the previous step contributes towards clearing the series of autocorrelation, differencing only is not enough. Pre-whitening decorrelates a series by removing its purely autoregressive statistical time series model. The difference between the actual series and the model created leaves us with residuals as white noise (tested with a measure by Bartlett, 1966). The autoregressive model obtained (its autoregressive lag structure and coefficients) is subsequently used to generate residuals also from the second series; only at this stage, cross-correlations between the two series' residuals may be meaningfully assessed.[5]

```
n<-length(d2imagery)  #Specifying the number of events in the series

X<-d2imagery
Y<-d2engagement
lag.max<-10       #Maximum acf lags to be used for the empirical analysis,
                  #here selected as 10 lags (5 seconds)

#code to proceed with pre-whitening:

acfX<-acf(X,plot=FALSE,lag.max=lag.max)$acf
acfY<-acf(Y,plot=FALSE,lag.max=lag.max)$acf
sdCCF1<-(1/n*(1+2*sum(acfX*acfY)))^0.5    #A vectorised multiplication of
                                          #the acfs, and the summation of
                                          #the results.
```

[5] For further details, see 'Pre-whitening' in the Glossary section of Bailes and Dean (2012).

```
criterion <- 1.96*sdCCF1      #Estimated 95% significance value for CCFs

prewhiten(d2imagery, d2engagement, ylim = c(-0.3,0.3), main ="Cross-
correlation after pre-whitening")         #Producing CCF graph after pre-
                                          #whitening
```

**4. *Granger causality*.** If significant cross-correlations emerge from the CCF graphs created, the Granger causality test may be used to assess whether a particular series statistically predicts the other, hence testing the possibility of a predictive causal relationship (Granger, 1969). In other words, the test compares the model in which a variable y is explained by an order of lags of variables y and x, against the model in which variable y is only explained by the lags of y. If variable x is Granger-causal, its preceding values help to predict y's current value (Dean & Dunsmuir, 2016). Significant lags identified from the cross-correlation function are used to define the number of lags (1 lag = 0.5 seconds), or 'orders', entered into the test. Whilst this test points out likely Granger-causal relationships, it does not however specify the quantitative impact of the variables involved.

```
grangertest(d2imagery, d2engagement, order = 2) # At 2 lags
                                                # Imagery -> Engagement
grangertest(d2engagement, d2imagery, order = 2) # Engagement -> Imagery
```

Once the series were stationary (following differencing of the data) and after completion of the pre-whitening phases of time series analysis, engagement and visual imagery series emerged as significantly related in all four pieces of music. This was the case for both the more and less musically experienced groups, as well as the global mean across all participants—the latter may be observed in *Figure 11*; further cross correlation function graphs may be found in Appendix 1.

The Granger causality test was then used to assess whether particular series statistically predicted the other (Granger, 1969); results per group and piece are summarized in Table 3. For the overall group grand mean series, engagement statistically predicts visual imagery, with the exception of Rachmaninov. When series were divided by musical experience, visual imagery statistically predicted the engagement series on four occasions, three of which emerged in the less musically experienced group series (for Debussy, Prokofiev and Rachmaninov). Engagement

predicted visual imagery on three occasions: twice amongst the more musically experienced group series (Debussy and Prokofiev), and once in the less musically experience group (Leginska). The Granger causality for Leginska's more musically experienced group was not statistically significant in either direction, despite the significant lags confirmed by the cross correlation functions. It therefore appears that whilst a meaningful relationship between imagery and engagement series has been established, when directions of influence are considered individually (imagery predicting engagement and vice versa), their predictive strength is insignificant. Hence, a bidirectional relation of the series may be more likely in this case, although engagement predicted imagery in Leginska's other groups and series.

**Individual Differences**

In order to explore individual differences, each participant's continuous data were averaged into a single mean value for each measurement (imagery and engagement) per piece. Data collected from both questionnaires and mean values of continuous ratings were tested for violation of normality; some data categories deviated significantly from normal. Two of the *Goldsmiths Musical Sophistication Index*'s (GMSI) sub-sections, the *Musical Training* battery, $W(34) = .90$, $p = .004$, and the *General Sophistication* battery, $W(34) = .93$, $p = .036$, significantly deviated from normal distributions. This was also the case for Debussy's imagery mean scores, $W(34) = .92$, $p = .019$; Leginska's imagery scores, $W(34) = .79$, $p < .001$; and Rachmaninov's imagery scores, $W(34) = .92$, $p = .016$. Spearman's rho correlation test was therefore used.

Mean engagement whilst listening to Leginska and Prokofiev showed particularly strong correlations to the participants' Gold-MSI's *General Sophistication* scores: respectively, $r_s = .50$, $p = .003$ ($r_s^2 = 25\%$); and $r_s = .51$, $p = .002$ ($r_s^2 = 26\%$). Mean engagement while listening to Debussy also correlated with the Gold-MSI *General Sophistication*, yet at weaker levels: $r_s = .36$, $p = .041$ ($r_s^2 = 13\%$); further correlations between the Gold-MSI batteries and participants' mean engagement ratings are displayed in Table 4. Prokofiev's liking scores also correlated with various subscales of the Gold-MSI, with the *General Sophistication* battery correlating at $r_s = .62$, $p = .000$ ($r_s^2 = 38\%$).

Mean absorption ratings correlated with five out of the six sections of the Gold-MSI, the strongest being *Active Engagement*, $r = .54$, $p = .001$ ($r^2 = 29\%$). Absorption scores did not correlate with any imagery or engagement ratings, but weakly correlated to the pieces' liking ratings. Stronger positive correlations were instead present between liking and engagement ratings (Table 5). No significant correlations emerged with the *Spontaneous Use of Imagery* questionnaire (SUIS). Correlation coefficients between *Spontaneous Use of Imagery* scores and mean engagement/visual imagery ratings were mostly weak positive (Debussy: engagement, $r = .10$, $p = .575$; imagery, $r_s = .13$, $p = .457$. Leginska: engagement, $r = .20$, $p = .276$; imagery, $r_s = .04$, $p = .838$. Rachmaninov: imagery, $r_s = .03$, $p = .866$), with weak negative coefficients on three instances (Prokofiev: engagement, $r = -.10$, $p = .588$; imagery, $r = -.04$, $p = .839$. Rachmaninov: engagement, $r = -.08$, $p = .648$). Mostly weak negative correlations that did not reach significance were observed between SUIS scores and the Gold-MSI subscales (correlation coefficients ranging from -.33 to .17), whilst SUIS and absorption scores correlated positively but weakly ($r = .22$, $p = .210$).

On average, more musically experienced participants' engagement and visual imagery ratings were higher than the less musically experienced (as observed in Figures 3–6). Two repeated measures ANOVAs were separately conducted for engagement and visual imagery ratings, with a between-subjects factor of more/less musically experienced, and within-groups factors of piece (Debussy, Leginska, Rachmaninov and Prokofiev). The ANOVA performed on the engagement ratings showed a significant between-subjects (more musically experienced group: M = 72.54, SD = 14.86; less musically experienced group: M = 52.97, SD = 14.86) effect: $F(1,30) = 13.89$, $p = .001$, ($\eta_p^2 = .32$), indicating significantly higher engagement ratings from the more musically experienced participants. Within-subjects, 'piece' was also a significant effect: $F(3,90) = 10.60$, $p < .001$ ($\eta_p^2 = .26$). Pairwise comparisons (Bonferroni-adjusted) were conducted to determine the details of this effect: Leginska's engagement ratings emerged as significantly lower than each of the other three pieces' engagement ratings, observable in *Figure 12* ($p$-values < .001 for comparisons with Debussy's and Rachmaninov's engagement ratings; and $p = .038$ with Prokofiev's engagement ratings). Pairwise

comparisons amongst the other pieces, however, did not statistically differ between them. The interaction between piece and participants' musical experience was also not significant: $F(3,90) = .22$, $p = .883$ ($\eta_p^2 = .01$). The second ANOVA was conducted on participants' visual imagery ratings. Whilst more musically experienced participants averaged higher imagery ratings than the less musically experienced group, interestingly this difference was not statistically significant (a comparison of the groups' average ratings, as obtained from the two ANOVAs, may be observed in *Figure 13*): $F(1,30) = 2.01$, $p = .17$ ($\eta_p^2 = .06$). Once again, 'piece' was a significant within-subjects effect: $F(3,90) = 9.13$, $p < .001$ ($\eta_p^2 = .23$); Bonferroni-adjusted pairwise comparisons showed that Leginska's visual imagery ratings were significantly lower than imagery ratings for Debussy ($p = .048$) and Prokofiev ($p = .001$), but not Rachmaninov ($p = .108$); visual imagery ratings in Prokofiev, however, were significantly higher than those for Rachmaninov ($p = .007$) (see *Figure 14*). Consistent with results from the previous ANOVA, the interaction piece x musical experience for visual imagery ratings was also not significant: $F(3,90) = .58$, $p = .627$ ($\eta_p^2 = .02$).

## Discussion

This study established a positive relationship between experiencing visual imagery and feeling engaged: this result was obtained while listening to 19th and 20th compositions for the piano. Such relationships were found for listeners who had been classified as more and less musically experienced. Details of the nature of the relationship between listeners' engagement and their experience of visual imagery were obtained through Granger Causality tests. Overall, engagement mostly predicted visual imagery, but differences by piece and musical experience are apparent. When groups were divided between more and less musically experienced, visual imagery predicted ratings of engagement mostly for the less musically experience group, whilst engagement predicted visual imagery more often for the more musically experienced group. Significant lags ranged between 2 and 7, representing 1 to 3.5 seconds of time. However, these results appear to vary by piece, and further research is needed to explore whether there are any musical properties associated with the nature of the relationship between engagement and imagery.

Our research sought to explore possible links between visual imagery and engagement, rather than to elucidate the mechanisms by which such links are formed, such as the potential role of affect; yet, a greater understanding of this relationship will help to advance theoretical understanding of how visual imagery and engagement co-occur. The BRECVEMA framework (Juslin et al., 2010; 2013) might predict that visual imagery precedes an emotional response, which could in turn enhance the listener's engagement. Alternatively, a certain degree of engagement with the music might be needed for visual imagery to occur. Factors shaping engagement with the music in the first place might include the degree of musical experience, familiarity with the style, as well as liking and the propensity to become absorbed.

More musically experienced participants reported overall greater levels of engagement and visual imagery than less musically experienced individuals, though this difference was only significant for ratings of engagement. A possible explanation for these results may be the greater variance in imagery response and their averaged scores. In addition, due to the complex nature of this variable, the reduction of a continuous imagery series to a single mean may not be as effective as, for instance, the averaging of an engagement series. Indeed, further speculations of varying experimental methods for visual imagery would be fruitful for further work in the field. For instance, whether averaged continuous series would considerably differ from self-reported single values, since research suggests that mean values derived from continuous data are generally lower than the values recorded when participants are asked to provide single summative scores (Brittin & Duke, 1997). Nevertheless, the overall higher imagery ratings from more musically sophisticated participants are in line with recent findings from Tavernaro (2016), which showed a correlation between listeners' visual imagery experience scores (composite score of imagery vividness, ease of imagery and time spent imaging) and the Gold-MSI's *General Sophistication* battery. Similarly, Küssner and Eerola's (2017) three visual imagery factors, as well as participants' VVIQ ratings, correlated with the *Emotions* battery of the Gold-MSI. It seems therefore that those with greater

musical experience might have a stronger tendency to experience visual imagery while listening to music.

Interestingly, the *General Sophistication* battery of the Gold-MSI also showed stronger positive correlations with ratings of engagement for the pieces by Prokofiev and Leginska: these pieces are characterized by more complex, unusual harmonies and frequent use of dissonances. These are possibly works that are less familiar and hence less accessible to less musically sophisticated individuals.

This initial overview of the data, however, showed a surprising lack of correlation between the *Spontaneous Use of Imagery Questionnaire* and any of the imagery ratings. Perhaps the experience of visual imagery while listening to music is qualitatively different to the experience of imagery in everyday life. Our finding is however consistent with literature suggesting that music serves to facilitate visual imagery (Quittner & Glueckauf, 1983; Band, 1996; Osborne, 1981). On the other hand it is also possible that, due to the complex properties of imagery and its rating, such grand mean levels (as obtained from averaging the entire continuous rating into a single mean) present greater challenges in producing an effective, representative mean value—particularly in relatively small samples.

Mean engagement ratings positively correlated with participants' liking of the pieces, suggesting that engagement with the music increases in line with its appreciation. The internalized, subjective nature of visual imagery experience makes it a complex phenomenon to investigate, and various limitations apply to the current study. Whilst the experimental tasks were designed to minimize complex, invasive tasks,[6] asking respondents to be consciously aware of, and then to rate, their engagement with the music they're listening to risks removing them from their engaged state in order to respond. Some individuals found rating their experience of visual imagery easier than others, feeling more or less able to accurately describe its content. Future research might explore

[6] CARMA software originally requires the use of a joystick or mouse to record continuous responses; the former did not allow a good sense of the scale's extremes when rating continuously, whilst the latter required the use of a computer screen—source of visual distraction for participants' visual imagery task.

the use of indirect measures of engagement, and relate the moments at which respondents report the occurrence of visual imagery to specific properties of the music (an example of a participant's imagery response may be observed in *Figure 15*).

Qualitative findings from the current study will be reported elsewhere. However, preliminary qualitative analysis suggested that listeners may experience varying imagery 'types'. For instance, more musically experienced subjects frequently imagine *performance* related scenes (such as a close-up of the pianist's hands or the performance setting, if not the score itself). Another frequent imagery type was the experience of *narratives*, a series of interrupted or continuous imagined events which evolve with the unfolding of the piece (*Figure 15*); or music *topics*, imagery closely related to the piece's musical features. This was a particularly interesting finding, in that recurring images would occur across different participants' experiences. Debussy's flowing patterns and harmonies, for instance, were frequently associated with water related images, whilst birds were a frequent mention whilst listening to Rachmaninov—likely to be a result of the opening fifth patterns appearing at the opening, as well as throughout the piece. Participants provided insightful qualitative details of their experiences. For instance, the way harmonies influenced the image in the mind, as this participant described in his annotations for Leginska: the 'odd harmonic progressions [led] to the image of a prison cell for the mentally ill, white walls, straight jacket'. Whilst engagement correlated with liking ratings, it is important to bear in mind that this is not necessarily always the case; one participant commented Prokofiev's piece in the interview:

> "*It's quite a repetitive piece, and the intensity builds and builds and builds, but you can't help but, you know, listen to it. It's engaging but in an irritating way, and I think that's what it's supposed to be doing*".

The positive relationship of engagement with visual imagery in the current research requires further clarification in other research domains of visual imagery. For instance, the discrepancy between mind wandering-related imagery—characterised by attention drifting away from any external task and its independence from perception (Smallwood & Schooler, 2015)—and the focused imagery of heightened engagement which can occur during music listening. Indeed,

these discussions, alongside further research, are to be moved forward. Nonetheless, the current study has provided initial empirical support for an association between the two, as well as having provided promising suggestions for future areas of investigation.

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Appendix 1

Cross correlation function graphs between pre-whitened engagement and visual imagery series for more/less musically experienced groups.

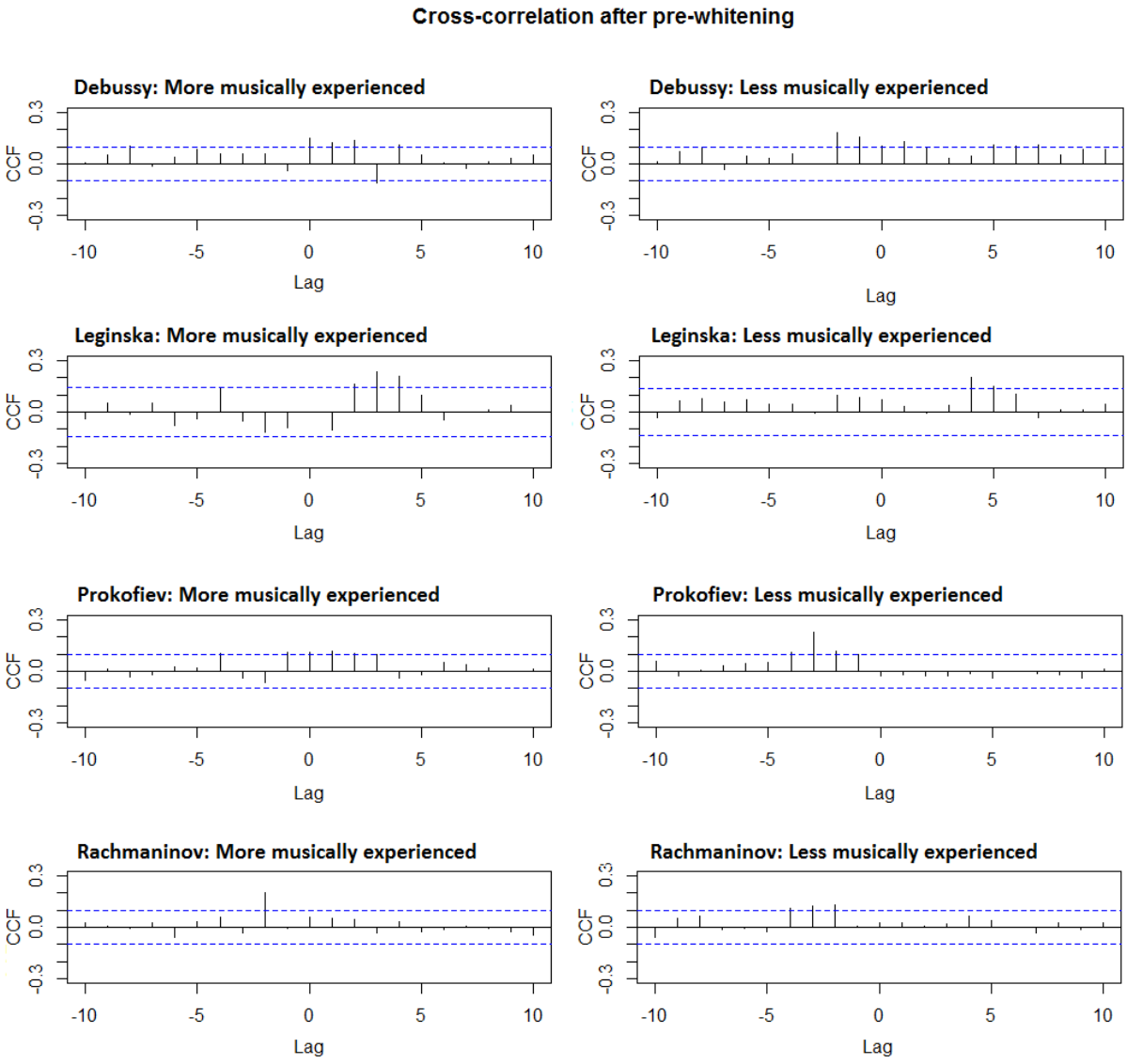

**Table 1**
***Participants' Demographic Details for the More/Less Musically Experienced Groups.***

| | **More musically experienced** | **Less musically experienced** |
|---|---|---|
| **Age** | M = 35.29, SD = 15.95 | M = 35.82, SD = 10.84 |
| **Sex** | 6 Females<br>11 Males | 10 Females<br>7 Males |
| **Gold-MSI *Musical Training* Scores** | Mdn = 39<br>(Range 32-45) | Mdn = 17<br>(Range 7-31) |

**Table 2**
***Details of Music Pieces Used as Auditory Stimuli.***

| Composer | Piece | Date of Composition | Track Length |
|---|---|---|---|
| C. Debussy | *Valse Romantique* | 1890 | 3’22” |
| E. Leginska | *Cradle Song* | 1922 | 1’40” |
| S. Prokofiev | *Suggestion Diabolique*, Op.4 No.4 | 1908 | 3’24” |
| S. Rachmaninov | *Étude-Tableaux* Op.33 No.4 (D Minor) | 1911 | 3’31” |

**Table 3**

***Outcome of the Granger Causality Tests per Group and Piece, Specifying the Level of Differencing Required to Achieve Stationarity of the Series (First or Second Order), the Significant Lags at Which Granger Tests are Performed and the Direction of the Granger Causality.***

| | | **Granger Causality** | | | |
|---|---|---|---|---|---|
| **Piece** | **Group** | Differencing | Lag | Direction | F |
| Debussy | More Musically Experienced | Second-order | 4 | Engagement → Visual imagery *** | 6.72 |
| | Less Musically Experienced | First-order | 7 | Visual Imagery → Engagement *** | 4.97 |
| | Overall Group | Second-order | 3 | Engagement → Visual imagery *** | 7.63 |
| Leginska | More Musically Experienced | Second-order | 4 | Engagement ↔ Visual Imagery | |
| | | | | Visual imag. → Engag. | 0.45 |
| | | | | Engag. → Visual imag. | 0.64 |
| | Less Musically Experienced | First-order | 5 | Engagement → Visual imagery * | 2.75 |
| | Overall Group | Second-order | 5 | Engagement → Visual imagery * | 2.49 |
| Prokofiev | More Musically Experienced | Second-order | 4 | Engagement → Visual imagery * | 3.14 |
| | Less Musically Experienced | Second-order | 4 | Visual Imagery → Engagement *** | 4.90 |
| | Overall Group | Second-order | 5 | Engagement → Visual imagery * | 2.69 |
| Rachmaninov | More Musically Experienced | Second-order | 2 | Visual Imagery → Engagement ** | 6.37 |
| | Less Musically Experienced | Second-order | 4 | Visual Imagery → Engagement * | 2.98 |
| | Overall Group | Second-order | 2 | Visual Imagery → Engagement * | 4.18 |

*Note*. Arrows indicate the direction of statistical prediction at the reported lag. Lags at which an association was found are included, with each lag representing 0.5 s. * $p < .05$, ** $p < .01$, *** $p < .001$

**Table 4**

***Correlations Between Absorption, Engagement Ratings per Piece, and Subscales of the Gold-MSI.***

| | | ***Goldsmiths Musical Sophistication Index* Scores** | | | | | |
|---|---|---|---|---|---|---|---|
| **Engagement Ratings** | | Active Engagement | Perceptual Abilities | Musical Training | Emotions | Singing Abilities | General Sophistication |
| Debussy | *n* = 33 | ***r* = .35*** | *r* = .12 | ***$r_s$* = .43*** | *r* = .20 | *r* = .25 | ***$r_s$* = .36*** |
| Leginska | *n* = 33 | ***r* = .55**** | *r* = .21 | $r_s$ = .34 | ***r* = .40*** | *r* = .32 | ***$r_s$* = .50**** |
| Prokofiev | *n* = 33 | ***r* = .39*** | ***r* = .36*** | ***$r_s$* = .49**** | *r* = .26 | ***r* = .66***** | ***$r_s$* = .51**** |
| Rachmani-nov | *n* = 34 | *r* = .25 | *r* = -.12 | $r_s$ = .29 | *r* = .16 | *r* = .17 | $r_s$ = .14 |
| **Absorption** | *n* = 34 | ***r* = .54**** | *r* = .18 | ***$r_s$* = .35*** | ***r* = .51**** | ***r* = .51**** | ***$r_s$* = .45**** |

*Note*. Values in bold indicate significant correlations. * p < .05, ** p < .01, *** p < .001

**Table 5**

***Correlations Between Participants' Mean Engagement and Liking Ratings per Piece, and Liking Ratings and Absorption Scores.***

| Engagement Ratings | Liking Ratings | | | |
|---|---|---|---|---|
| | Debussy | Leginska | Prokofiev | Rachmaninov |
| **Debussy** | $r_s$ = .84*** <br> $n$ = 33 | | | |
| **Leginska** | | $r_s$ = .60*** <br> $n$ = 33 | | |
| **Prokofiev** | | | $r_s$ = .82*** <br> $n$ = 33 | |
| **Rachmaninov** | | | | $r_s$ = .71*** <br> $n$ = 34 |
| **Absorption** | $r_s$ = .49** <br> $n$ = 34 | $r_s$ = .37* <br> $n$ = 34 | $r_s$ = .35* <br> $n$ = 34 | $r_s$ = .42* <br> $n$ = 34 |

*Note***.** No significant correlations emerged between absorption scores and engagement ratings.

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

***Figure 1*. Experimental set-up for the listening tasks.**

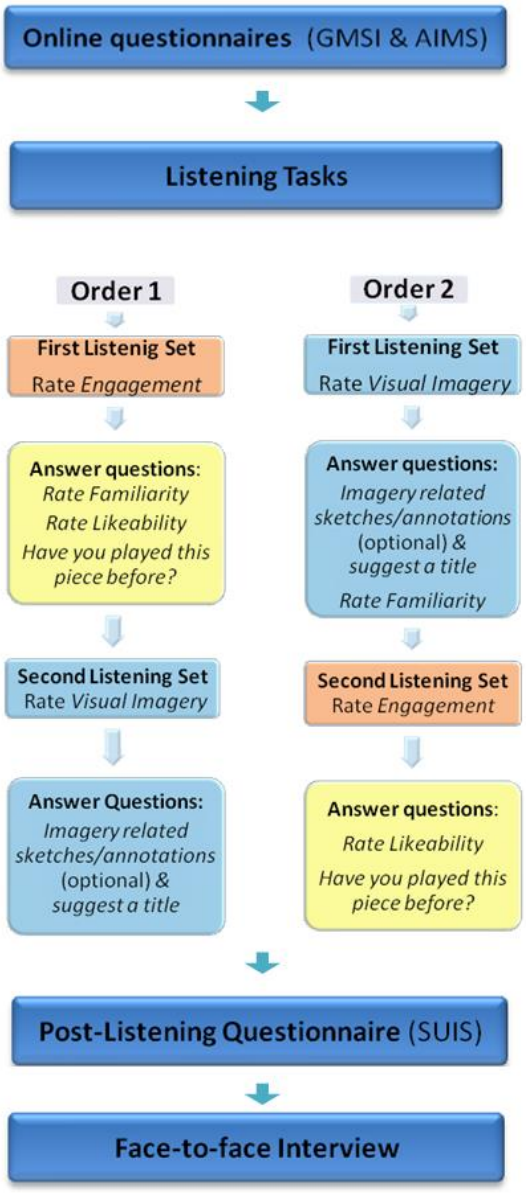


***Figure 2*. Experimental procedure and order of tasks.**


***Figure 3*. Responses to Debussy's *Valse Romantique*.**

The top panel displays participants' overall mean **engagement** and **visual imagery** ratings (sampled every 0.5s) in response to Debussy's *Valse Romantique*. The two lower panels compare responses from the more musically experienced and the less musically experienced groups for engagement (central panel) and visual imagery (lower panel).

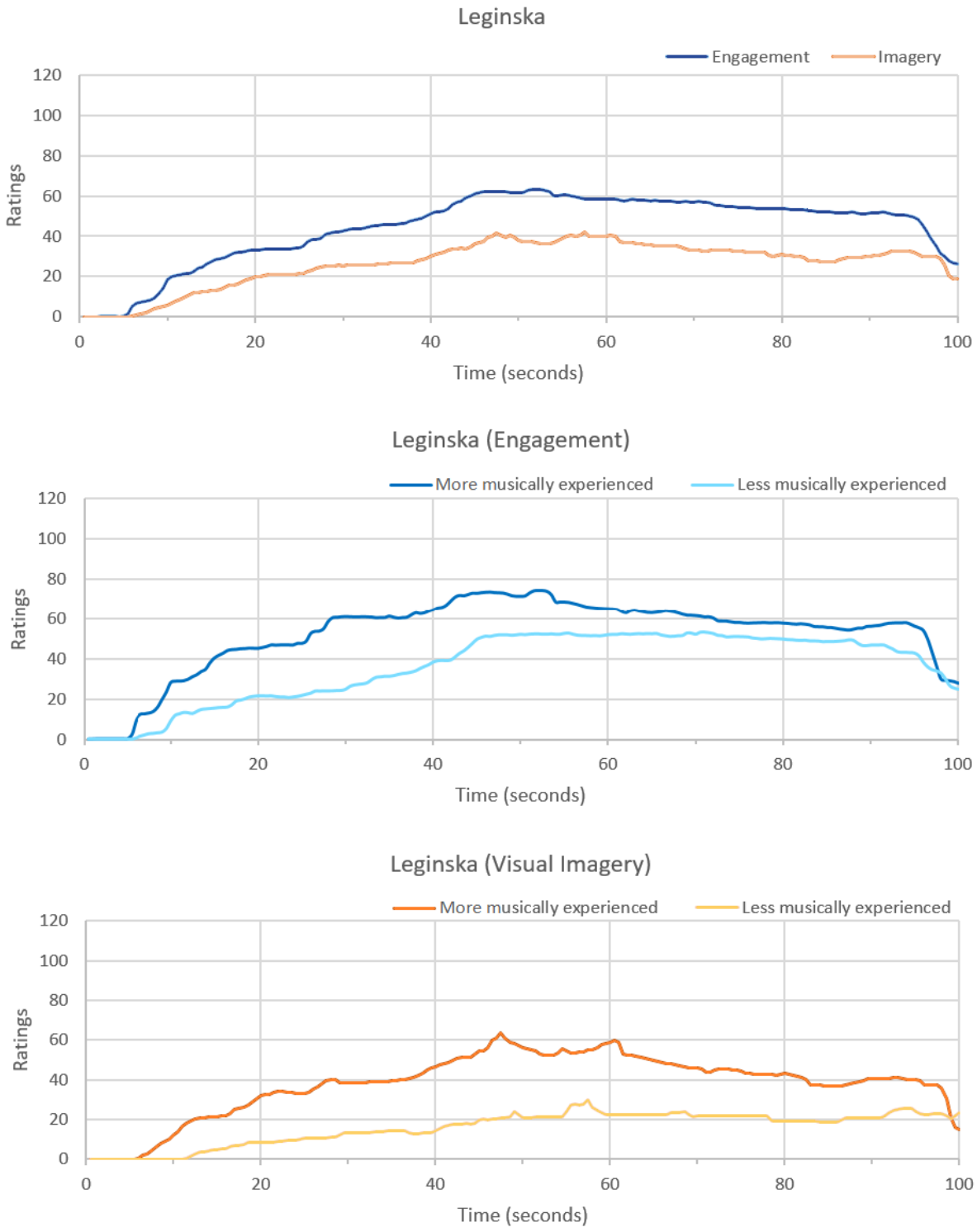


***Figure 4*. Responses to Leginska's *Cradle Song*.**

The top panel displays participants' overall mean **engagement** and **visual imagery** ratings (sampled every 0.5s) in response to Leginska's *Cradle Song*. The two lower panels compare responses from the more musically experienced and the less musically experienced groups for engagement (central panel) and visual imagery (lower panel).

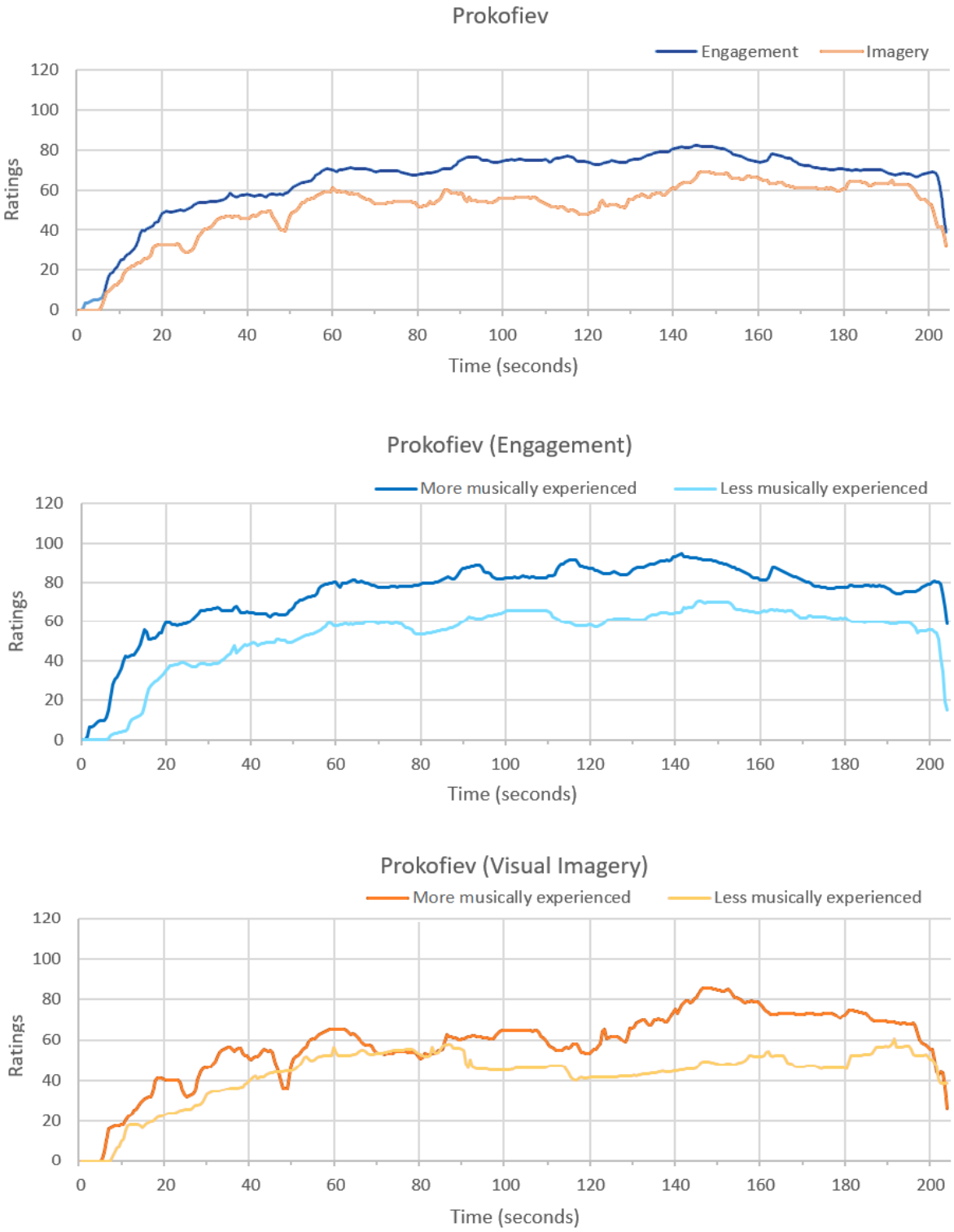


***Figure 5*. Responses to Prokofiev's *Suggestion Diabolique*.**

The top panel displays participants' overall mean **engagement** and **visual imagery** ratings (sampled every 0.5s) in response to Prokofiev's *Suggestion Diabolique*. The two lower panels compare responses from the more musically experienced and the less musically experienced groups for engagement (central panel) and visual imagery (lower panel).

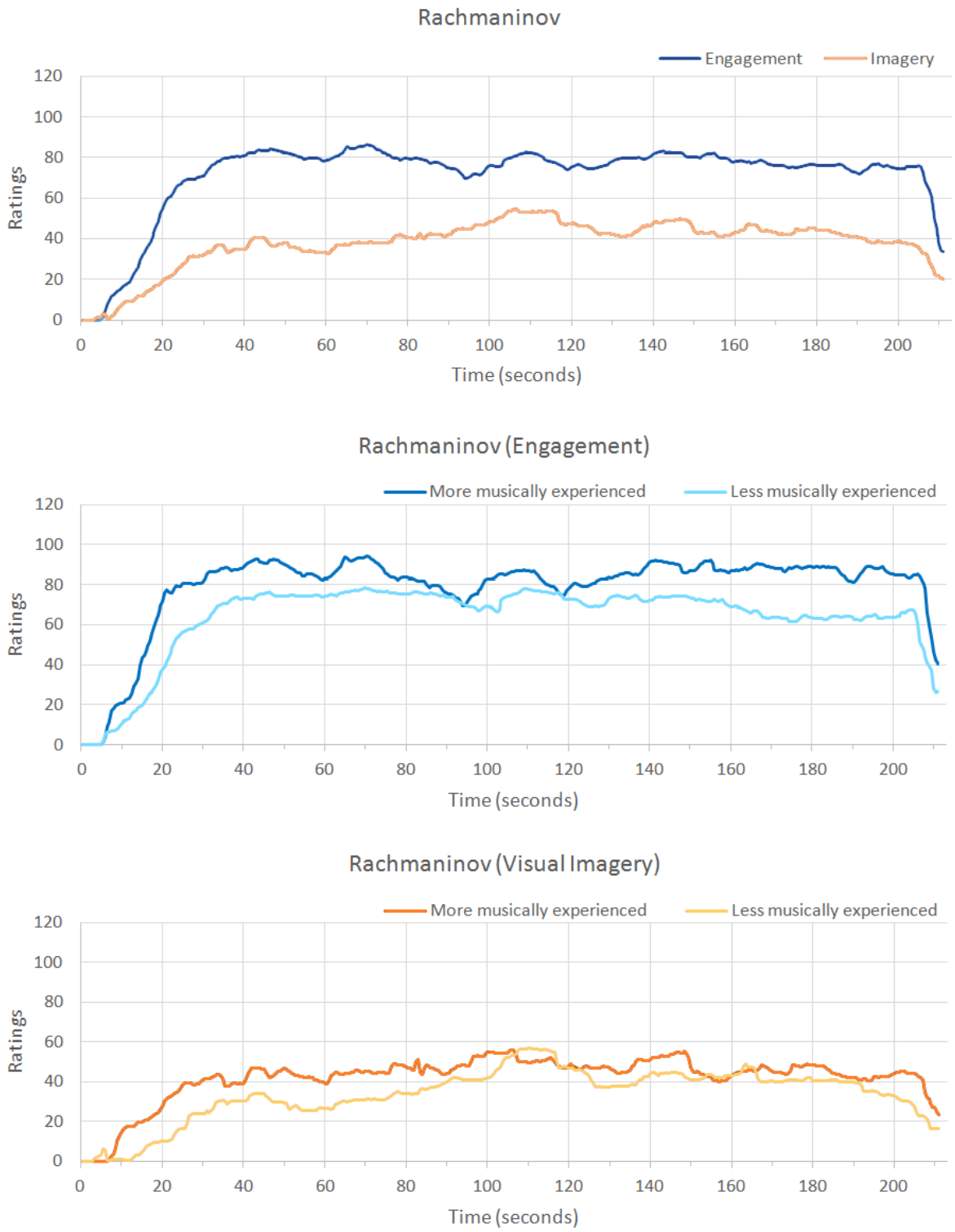


***Figure 6*. Responses to Rachmaninov's *Etude-Tableaux* Op.33 N.4.**

The top panel displays participants' overall mean **engagement** and **visual imagery** ratings (sampled every 0.5s) in response to Rachmaninov's *Etude-Tableaux* Op.33 N.4. The two lower panels compare responses from the more musically experienced and the less musically experienced groups for engagement (central panel) and visual imagery (lower panel).

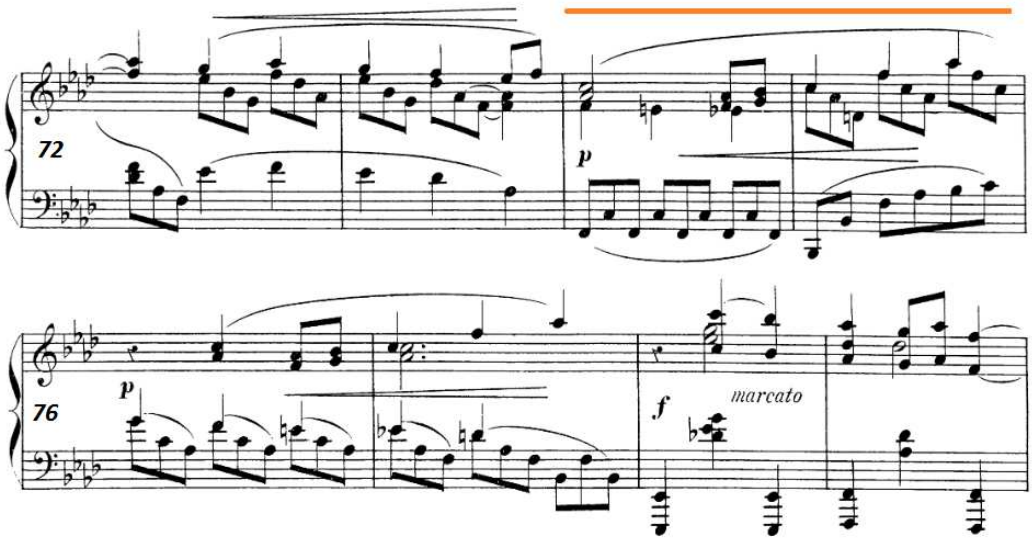


***Figure 7*. Debussy's *Valse Romantique*, bars 72–79; the horizontal line provides an approximation of the highest peak in averaged (mean) visual imagery ratings from the group.**

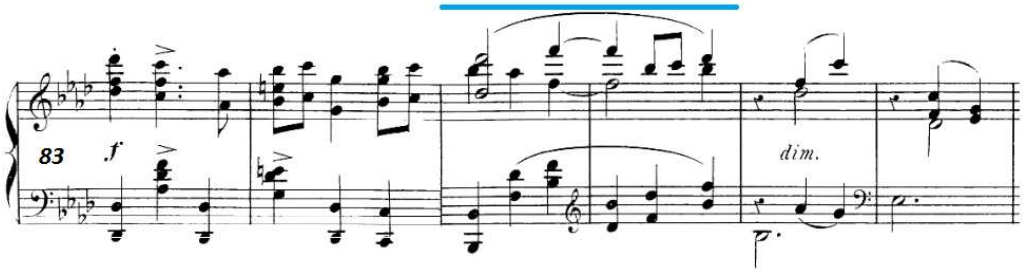


***Figure 8*. Debussy, bars 83–88; the horizontal line indicates an approximation of the highest peak in averaged (mean) engagement ratings.**

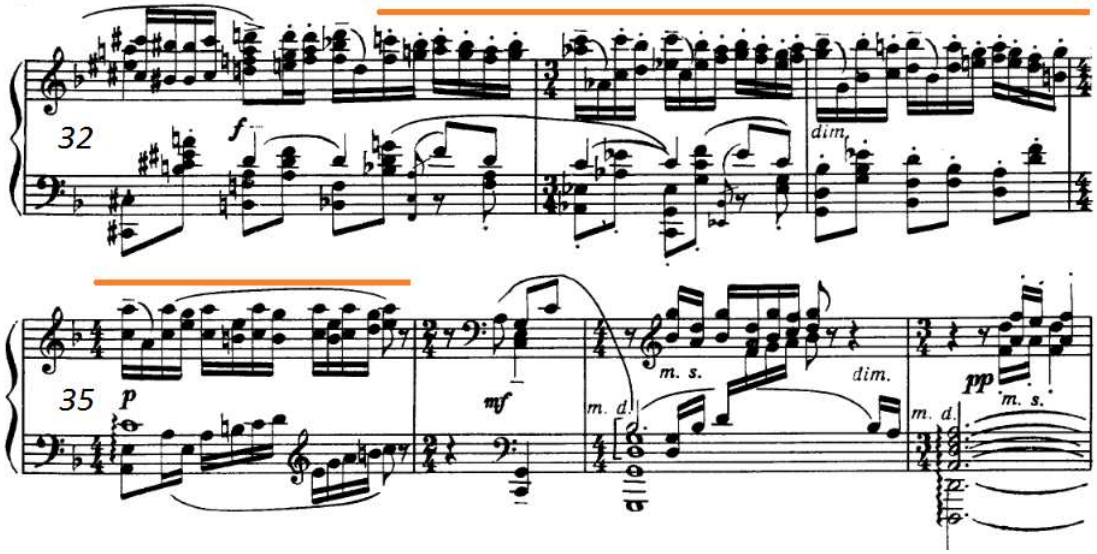


***Figure 9*. Rachmaninov's *Etude-Tableaux* Op.33 N.4, bars 32–38; the horizontal line indicates the highest peaks in visual imagery ratings.**

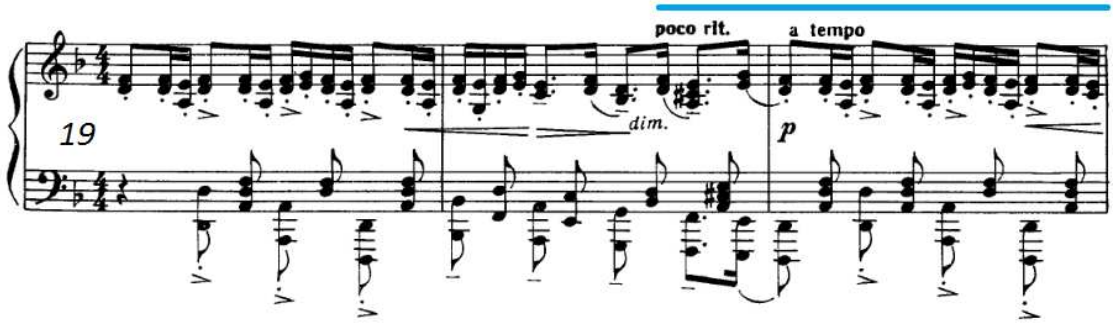


***Figure 10*. Rachmaninov, bars 19–21; the horizontal line indicates the highest peak in mean engagement ratings.**

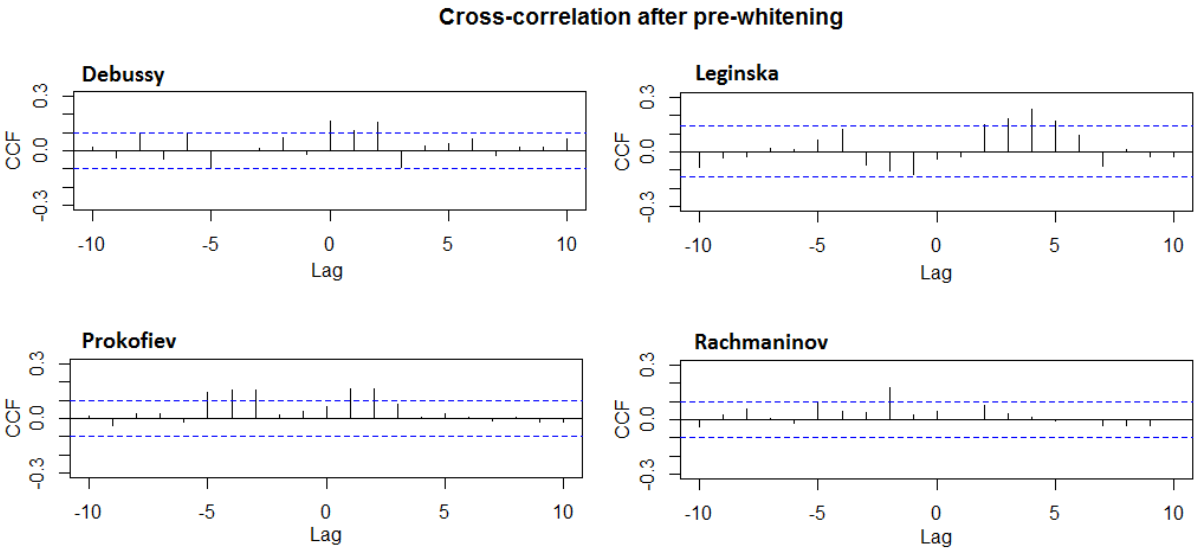


***Figure 11*. Cross correlation function (CCF) graphs between pre-whitened engagement and visual imagery global mean series (all participants merged into a single group), per piece. Statistical significance is indicated by the vertical line/s exceeding the upper horizontal line.**

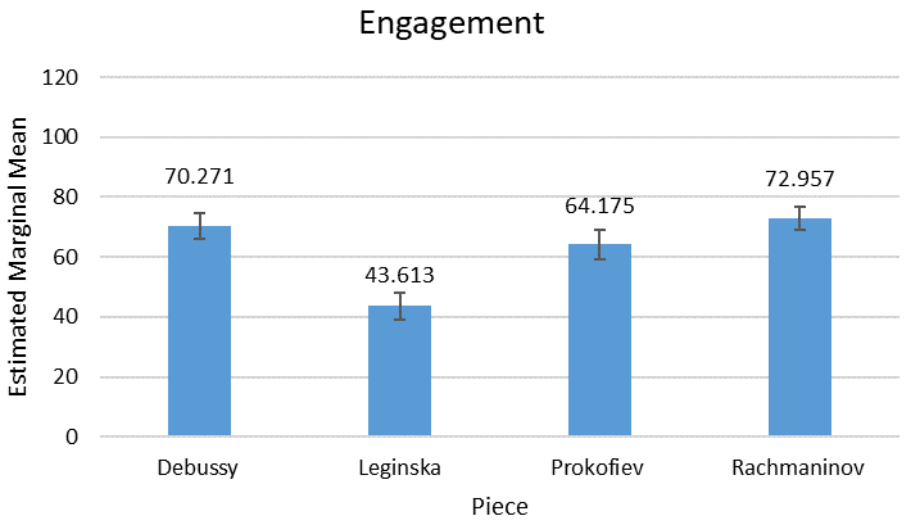


***Figure 12*. Estimated marginal means of participants' engagement ratings, as derived from the repeated measures ANOVA's main effect piece. Error bars report standard error of the mean.**

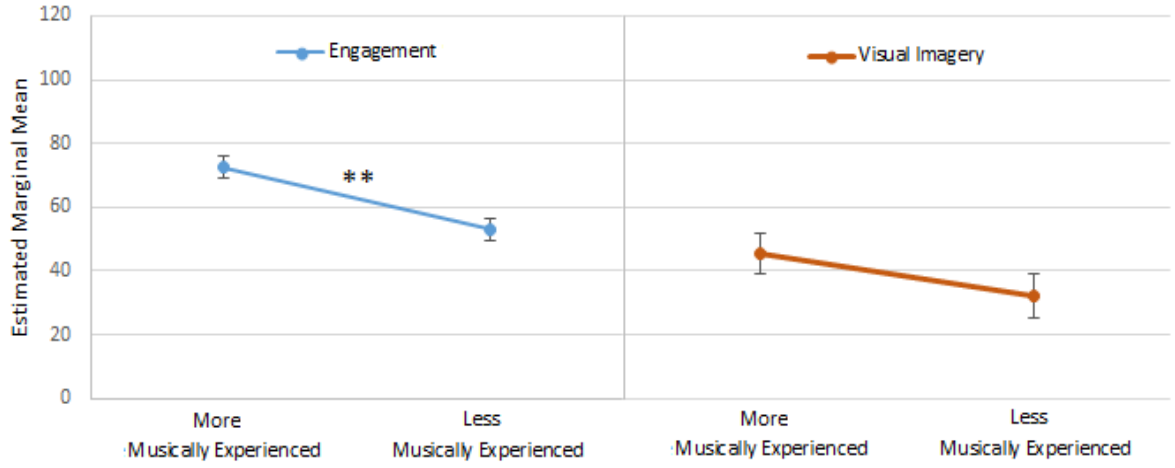


***Figure 13*. Comparison of the estimated marginal means from the more/less musically experienced groups, as derived from the ANOVAs independently performed on participants' engagement ratings (left) and visual imagery ratings (right). Only difference in engagement ratings between the two groups was statistically significant (** $p < .01$). Error bars report standard error of the mean.**

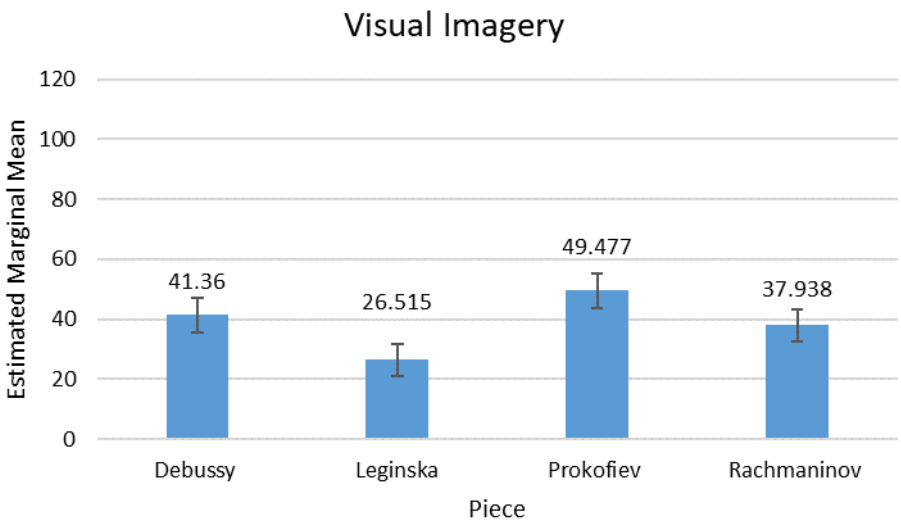


***Figure 14*. Estimated marginal means of participants' visual imagery ratings, as derived from the repeated measures ANOVA's main effect piece. Error bars report standard error of the mean.**

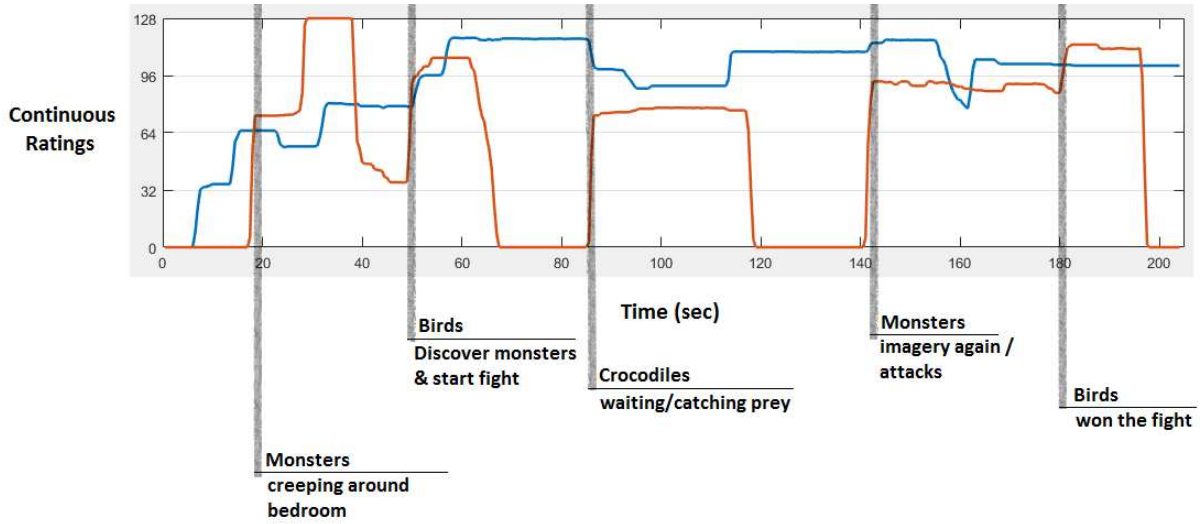


***Figure 15*. A participant's continuous ratings for engagement (blue line) and visual imagery (red line) whilst listening to Prokofiev. The imagery ratings and annotations capture the interrupted narrative imagined.**