Spectators' Aesthetic Experience of Sound and Movement in Dance Performance: A Transdisciplinary Investigation

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Abstract

We utilise qualitative audience research and functional brain imaging (fMRI) to examine the aesthetic experience of watching dance both with and without music. This transdisciplinary approach was motivated by the recognition that the aesthetic experience of dance revealed through conscious interpretation could have neural correlates in brain activity. When audiences were engaged in watching dance accompanied by music, the fMRI data revealed evidence of greater intersubject correlation in a left anterior region of the superior temporal gyrus known to be involved in complex audio processing. Moreover, the qualitative data revealed how spectators derived pleasure from finding convergences between two complex stimuli (dance and music). Without music, greater intersubject correlation was found bilaterally in a posterior region of the superior temporal gyrus, showing that bodily sounds such as breath provide a more salient auditory signal than music in primary auditory regions. Watching dance without music also resulted in increased intersubject correlation amongst spectators in the parietal and occipitotemporal cortices, suggesting a greater influence of the body than when interpreting the dance stimuli with music. Similarly, the audience research found evidence of corporeally focused experience, but suggests that while embodied responses were common across spectators, they were accompanied by different evaluative judgements.

Keywords: aesthetics, dance, fMRI, multisensory, qualitative

Spectators' Aesthetic Experience of Sound and Movement in Dance Performance: A Transdisciplinary Investigation

In this paper we discuss a study that was carried out as part of the Watching Dance: Kinesthetic Empathy project (www.watchingdance.org). The Watching Dance project. This was a transdisciplinary exploration of the extent to which spectators' experiences of dance were based upon kinesthetic empathy. The present paper focuses on spectators' aesthetic experience of sound and movement, investigated through a combination of qualitative audience research and functional brain imaging (fMRI).

As a multi-modal form, dance invites research into how different sensory modalities interact with each other. Although the relationship between dance and music is central to Western theatre dance practice (see for example Jordan, 2000; 2008), and has begun to be addressed by neurocognitive approaches (Jola, et al., 2013), it has not hitherto been studied in combination with qualitative research on dance audiences in theatre settings. Our approach parallels the recent proposals of how aesthetic aspects of dance can (Christensen & Calvo-Merino, 2013) and should (Jola & Christensen, 2015) be a subject for empirical research into the audience experience. Further, our research emphasis aligns with the current surge of interest in multisensory aspects of performance (Banes & Lepecki, 2007; Bläsing, 2015; Chapple & Kattenbelt, 2006; Di Benedetto, 2010; McKinney, 2012; Vass-Rhee 2010; 2011; Viaud-Delmon et al. 2012). Within this context of developing research into the multi-modal aspects of dance, our aim was to research audiences' responses to dance movement when accompanied by different combinations of movement and sound.

The specific question we set out to investigate was: what is the effect of different sound scores on spectators watching a particular dance section? Does the auditory stimulation when watching dance have an effect on the kinesthetic experience and/or the aesthetic appreciation of the spectator? And how is this experience altered when music is removed, and spectators just hear the performers' breathing and footfalls?

We argue that accounting for both conscious interpretive meaning-making *and* neuronal processes of cognition allows optimal engagement with the complex real-world phenomenon of dance spectatorship. As Sobchack (2004) states, being human "entails the body and consciousness, objectivity and subjectivity, in an irreducible ensemble" (p. 4), requiring a holistic understanding of spectators' aesthetic experiences. With this perception in mind, we used two distinct approaches – cognitive neuroscience and qualitative audience research – to investigate responses to the same stimulus material. In this study these disciplines were connected through working methods of complementarity (i.e. seeking elaboration, enhancement, illustration and clarification of the results from one method with the results from another) as well as through triangulation (i.e. seeking convergence, corroboration, correspondence and implementation of the results from one discipline to the other) (see Bryman, 2006; see also Reason et al., 2013). The qualitative audience research findings informed the design of the neuroimaging research, in particular with regards to the choice of appropriate stimuli and the formation of hypotheses relating to specific brain activity. They also impacted on the interpretation of identified brain activity, as suggested by McKinlay, McVittie, and Della Sala (2010), who propose that qualitative forms of analysis might provide additional means of making sense of data. In turn, the neuroscientific findings may evidence the neuronal processes underlying conscious dance perception experiences.

General Method

The Stimulus Material

To examine specific questions relating to spectator experiences of the relationship between sound and movement, it was necessary to work collaboratively with a choreographer to produce a short dance work that brought these issues to the forefront. The Watching Dance team specifically wanted to work with a choreographer who would find the experience of adjusting an existing piece to the needs of scientific investigation genuinely useful for their own work. To this end, the team approached Rosie Kay, a choreographer with an established reputation in contemporary Western theatre dance, whose aims and interests were relevant to our research.

The resulting work was entitled *Double Points: 3X*, and was an adapted performance that incorporated aspects of laboratory experiment into professional choreography, and that would be used as stimulus material in both the neuroimaging and qualitative research.

. *Double Points: 3X* has its origins in a previous work by Kay, titled *Double Points: K* (2008). This, itself, was a re-interpretation of a seminal choreography by the Netherlands-based dance company EmioGreco|PC, titled *Double Points: Two* (1999). In this work the lack of a narrative form, a heightened awareness of breath sounds that resulted from the levels of exertion, and the use of silence made it particularly suitable for adaptation for this research study.

Kay set about adapting the work to intensify the focus on music/sound and movement. The work was shortened and adjusted to have fewer variables, enabling a more direct comparison to be made between different moments. Kay created a five minute choreography that incorporated several important elements of the work, including partner work and running and travelling phrases. This five-minute section was then repeated three times (hence *Double Points: 3X*) to three sections of music, each of five minutes. The three soundscapes were 1) Bach's 'Concerto for Oboe and Violin in C Minor', Allegro, 2) Breath (no music or digital soundscape but ambient sound, including the performers' breathing and footfalls), and 3) Electro (composed by Ian Wallman); these were performed in the given order during the performance.

Double Points: 3 x is a male/female duet, with the dancers wearing grey tunic-like dresses, with bare feet. The dancers start by facing towards the audience diagonally, then meet together in movements of stretched arms and legs, joining together in a quick pas de deux of short lifts and manipulations, limbs slicing between the spaces created by the dancers' bodies, pulling through and pushing back. With their backs to the audience, the dancers begin a unison section of extended reaches, balletic arm positions and synchronized timing. This develops into a turning sequence; each dancer circling the other, arms outstretched in couru turns, building to both spinning around the stage, ending at opposite corners. The dancers spin their arms in windmill-like movements, before rushing towards each other, with quick gallops into a sequence of fast runs on demi-pointes, spinning and circling arms and little leaps. At the end the dancers rush towards the audience, arms outstretched as if to fly, bodies breathing in time together, before returning to their starting positions.

In the studio, Kay and a second dancer Morgan Cloud rehearsed with stopwatches to ensure that each section was as identical as possible, practicing it in silence most of the time so that the Breath version became the basis of the timing rather than the music cues. Despite this deliberate intention, in the live performance the Breath section was slightly longer than those performed to music, perhaps as a result of not having the clear tempo of the music to direct the speed.

Owing to Kay's artistic intervention, the performance also had short introductions and endings. In the original *Double Points: K* there is a 5.30 minute long opening, where the dancers travel across the stage on demi-pointe with their backs to the audience, gradually revealing themselves to the audience before the first part of the Bach Concerto begins. Without this opening, Kay felt that the work would lack performative qualities: there would be no room for the audience to relax, join the space, adjust their perception to the dark of the theatre and become familiar with the bodies and personalities of the dancers. Short film versions of *Double Points: 3X* can be viewed online at http://tinyurl.com/bol4nsg.

Audience Research Framework

Overview

In September 2009, an invited audience watched the dance performance at the John Thaw Studio Theatre, University of Manchester. Qualitative audience research typically engages participants in wide-ranging, reflective conversation (Barker, 1998). It is often utilised in connection with real world situations, where the focus group format can have much in common with the post-show conversations that form the natural aftermath of a social visit to the theatre with a group of friends (Sauter, 2000). From across the broad spectrum of qualitative methodological frameworks, the particular epistemological underpinning for the qualitative audience research undertaken for this paper is that of participatory enquiry into the phenomenological experience of watching dance.

Phenomenology as a method of philosophical inquiry perceives the world as made meaningful through its encounter with a subjective agency. As Max van Manen (1990) writes, “the world itself, without reference to an experiencing person or consciousness cannot be described directly, [as] such approach would overlook that the real things of the world are always meaningfully constituted by conscious human beings” (p. 9). Participatory methods of qualitative research particularly lend themselves to phenomenological enquiry owing to their ability to account for experiential knowing (Heron & Reason, 1997). Creswell (2009) describes the participatory worldview as one that sees meaning as “constructed by human beings as they engage with the world they are interpreting” (p. 9).

Method

We therefore sought to investigate audiences’ lived experiences of dance through collaborative dialogue with spectators, setting out to uncover what Lincoln, Lynham, and Guba (2011) describe as a “critical subjectivity and self-awareness.” We operated through actively engaging spectator-participants in the research questions and in their experiences of *Double Points: 3X*. The focus groups therefore began with researchers explicitly outlining the nature of the research projects and the kinds of questions that we were seeking to explore through the discussions. Responses were facilitated by the nature of the stimulus material itself, where the same sequence of movement was repeated against altering soundscapes (Bach, breath, electro) in a structure that actively invited conscious reflection. For example, one participant commented:

> One of the things that struck me was the difference the music made to the cycles. I suddenly realised that it was partly the same choreography and the difference the music made to the physicality of this dance. (Morag, experienced spectator)

In other words, the question of the relationship between sound and movement was an element of conscious reflection within the experience itself.

Participants

A total of 15 participants (9 female and 6 male) took part in two 90-minute workshops that immediately followed the performance. Participants were grouped by their level of dance watching experience, with one group (numbering 9) of experienced spectators, who on average watched three or more performances a year, and one group of novice spectators (numbering 6), who on average watched fewer than one dance performance a year. None of the participants had any experience as dancers or of dance training beyond childhood. In this paper the level of spectators' watching experience is indicated after their names. Experienced spectators were selected from respondents to questionnaires circulated in local dance venues (particularly The Lowry, Manchester) which enabled identification of frequent dance attenders. Naturally novice spectators could not be recruited from amongst audiences already at dance performances and these participants were instead recruited through open calls via university email lists and personal networks. This element of the study was approved by the Ethics Committee of the Faculty of Arts, York St John University. Participants' consent was obtained both at the recruitment stage and verbally during the focus groups. In this document all participants' names have been changed.

Procedure

Due to the live nature of the performance it was not possible to counterbalance the order in which spectators saw the three sections of the dance. All live spectators therefore saw the same order of sequences: Bach, Breath and Electro.

Three researchers from the Watching Dance team facilitated the workshops, each following the same format and exploring the same core research questions. The workshops were designed to enable the kinds of phenomenological engagement that underpinned the methodology, through a combination of structured memory exercises followed by open discussion. The memory exercises (adapted from Critical Incident Technique and the use of Projective Techniques in media research) utilized pen and paper tasks that had a mediating function and invited active thinking. These approaches were developed in previous audience research carried out by members of the project team (for example Reason 2006) and are a methodological approach that has also been adopted by audience researchers in different contexts (Hansen, 2011). Table 1 provides further details of the four main exercises undertaken in the workshops and their roles in both data gathering and participatory analysis.

All the focus group discussions were audio recorded and transcribed. As researchers we located ourselves *within* the participatory enquiry rather than outside. That is to say, we were researching with the participants, rather than external experts researching on them or even researching into them. The activities outlined above therefore represent both processes of data gathering *and* processes of analysis in which the participants themselves developed themes of interpretation throughout the course of the focus groups. These are discussed below under the headings ‘music and movement perception’ and ‘breathing and movement perception’.

Results and Discussion

Music and movement perception. One of the anticipated outcomes of the experiment was that changing the soundscape would change the spectator’s emotional interpretation of the movement. This was confirmed, and also explicitly recognised by the participants themselves, such as David (experienced spectator) who observed how the combination of the “repetitiveness” of the dance with “different backing music or lack of music inspired different emotions at each time […] You change the music, you don’t change the dance, you repeat the dance, and it’s got a totally different emotional effect.”

For several of the participants, the changing soundscape made them question the exactness of the repetition in the movement. Olivia (novice spectator) explained, “I was not sure that they were the same movements, so I kind of had this question in my mind, were they dancing the same way?” While the performers Kay and Cloud were extremely careful to keep the sections as identical as possible, the spectators were frequently unable to convince themselves that this was the case, given the different emotional feelings produced. Indeed, there were inevitable slight differences, with the Breath section being slightly longer, as Clive (experienced spectator) intuitively recognised:

> I found myself thinking that even though I know that is probably exactly the same movement, is it my imagination or is the music bringing out slight differences in the dance performance itself as well as my perceptual bit. Was the Bach more elegiac and flowing? Was the Breath accompanied one more staccato with more emphasis and was the final piece, I don't know what to call it, jazz piece, was the movement slightly more syncopated, I don't know I found these impressions coming into my mind.

Here Clive is explicitly wondering about the extent to which his perception of the movement was directed by qualities associated with the music. Are we able to trust ourselves to read what we see; or does our aural experience alter our visual perception? For many participants the Bach section was described as more “elegant”, “flowing”, “relaxing” and “lyrical”, with one spectator convinced that for this section the movements were executed with “very kind of exaggerated broad gestures, very related to the baroque style”. The electronic score by contrast was described as “big”, “brighter” and “bold”, with a more “competitive” relationship between the performers. The Breath segment similarly created its own particular atmosphere, as will be discussed in more detail in a moment.

For many of the participants, this increasing awareness of how music influenced and even made them doubt their visual perception was a consciously fascinating experience. It was something discussed in the workshops, such as in this exchange between experienced spectators:

> **Clive:** I wondered how much it actually did change […] whether they had just said, just allow yourself a little bit to vary with the music, let it give you that emphasis, or whether I was just imagining it.

Vanessa: I just thought that [it was] the same movements but the emphasis was different. Whether it's the music that gave the emphasis or the dance or my response that gave it the emphasis there did seem to be a different emphasis.

David: I thought that I was interpreting it. I thought that they were moving the same. I thought I was interpreting it rather than them moving differently.

Luke: I think that there was no improvisation in here, it was pretty strictly choreographed.

These discussions underscore how music informs the interpretations placed on dance movement. As several participants observed, music is often a 'short-cut' to provoking emotions and feelings.

The performance also prompted participants to discuss how dance is rarely witnessed without music. Indeed, this close connection between movement and music is a key motivation for some spectators: "I want to see that immersion in music, that place with music and dance where there is no end, there's no break between the two" (Pamela, experienced spectator). For some spectators this led to moments when the two would become mutually generative and dependent, with Luke (experienced spectator) describing how with one gesture the performers "extended into the sounds with their arms and legs, they cut a shape in the air as if it was almost sort of in the sound", while Clive (experienced spectator) noticed that certain sounds "seemed to generate certain movements" or at least encourage those movements to become visible.

This exploration of the audience's discussions about *Double Points: 3X* confirms that music does much to shape and direct spectators' reading of dance movement – and indeed their memory of what the movement was. The sound/music accompaniment to dance scores the movement, directing the emotional and physical reading of the movements. The music, in other words, has a kind of diacritical function, in that it directs our watching.

Breathing and movement perception. One of the soundscapes used in *Double Points: 3X* was the explicit absence of music, which brought into focus instead the sound of the performers' footfalls and their breathing. Like the different musical scores, this silent or ambient soundscape also did much to direct the audience's reading of the movements in specific and distinct manners. It is worth noting that while the removal of music made other sounds (footfalls, ambient room noises, other spectators) more audible, spectators' reports overwhelmingly focused on the sound of the performers' breathing.

In other ways, however, the spectators' responses to the Breath soundscape were more diverse than with the musical scores, and in particular provoked more divergence in expressions of taste. One reason for this is likely to be because the use of breathing as a dance accompaniment is more unusual and therefore has less accumulated or established expectations surrounding it. For example, as Olivia (experienced spectator) commented, "I remember that when the classical music started I was expecting the moves of that kind of music"; in contrast, the lack of music had no accumulated expectations, except perhaps the very absence of movement. As Sunil (a novice spectator) commented:

> People automatically think: dancing, music. I think it just triggers into your head, dancing goes with music; just like when you think of music, dancing automatically triggers, dance without music seems ridiculous to me, it just seems completely strange.

One of the observations of the Breath section was of how the dancers' breathing became "a sort of rhythm" (Ray, novice spectator) and "was giving an extra rhythm to it, you know even when there was no music there, there was really, coming from the breath which was quite interesting" (Luke, experienced spectator). Other participants described how the breath became a form of "punctuation", or that it had a "percussive quality".

Of course, while audible breathing is uncommon and unexpected as a soundtrack to dance, it is itself loaded with broader cultural associations. The most prominent of these is its evocation of bodily presence, exertion and physicality. While the movements for this section were, insofar as possible, exactly the same as during the other sections of *Double Points: 3X*, the tendency amongst spectators was to perceive it as more physical and as more exhausting for the dancers. Whether they personally liked this section or not, spectators made similar comments about the impact of the breathing on their experience.

Morag (experienced spectator), for example, became more "aware of the physical nature of it" and "more aware of the exertion of the dancers"; for Ian (novice spectator) "it hit me right in the face, you know, it's much more intense"; for Clive it emphasised "the effort, pain, the intensity that goes into creating a dance piece"; while Peggy (experienced spectator) commented on "the sense that there was that rhythm coming through their bodies and not from an external source". Across the responses to the Breath section there was evidence of a heightened sense of the physical presence of the performers ("The breathing made you very aware of their physical presence, of them as people and bodies" - Elizabeth, experienced spectator) and heightened awareness of physical effort ("You can feel the hard work that is going on there" – Ian, novice spectator). The result was a more intense experience, as in this conversation between three experienced spectators:

Pamela. The silent movements [were] much more intense

Alan. Much more intense when there is no music

Clive. The breathing with movement emphasised […] the effort, pain, the intensity.

We would suggest that the Breath section triggered a shift from a visual mode of engagement to experiencing a proprioceptive sensation, a body-to-body effect. This was not necessarily perceived as a positive experience, with some spectators turned off by the increased intensity, as shown in this exchange between a researcher and participant:

> **Pamela:** Um I remember the different emotions that I felt at different stages of the dance and the sequences, um and how uncomfortable I felt at times.
>
> **Researcher:** What times did you feel uncomfortable?
>
> **Pamela:** When there was, when there was no music. I found that it was too intimate. I, I felt too close. I, I didn't want to feel like that.

In some ways Pamela's reading of the effect of the breathing on the experience is the same as those discussed above – of increased intimacy and intensity – with the difference being that her emotional response to this was very different. What is worth noting is that this response was shared by both experienced spectators, such as Pamela, and novice spectators such as Grace, whose response was similar to Pamela's:

> The breathing I felt the breathing made me feel uncomfortable which was interesting and it made the dance seem very edgy erm I didn't like it. […] It made me feel uncomfortable and breathless.

This relationship that Grace describes between the breath of the spectator and the breath of the performer is an observation echoed by another novice spectator, who stated, "It was making me hyperventilate". In another paper (Reason and Reynolds 2010), we have explored how across a diverse range of dance performances, different spectators bring different kinds of interpretative or viewing strategies to the experience of watching dance, with some motivated by a desire for physicality and viscerality, while others seek out experiences that satisfy an appreciation of effortlessness and grace. For this latter group of spectators, exemplified here by Grace and Pamela, the Breath section was less appealing than those sections where the music distanced the physicality of the performance. Indeed, there was a frequent expression of almost physical relief when the silent section ended and the music returned. What was noticeable was that this rough division between spectators drawn to viscerality and those attracted by gracefulness – or here more prosaically between those who either liked or disliked the Breath section – cut across levels of experience and background. In other words, rather than being something that depended on levels of experience of either spectating or dancing, it was something connected to a more personal taste, motivation and perception. However, it is the suggestion that the Breath section triggered a shift from a visual mode of engagement to experiencing a proprioceptive sensation, a body to body effect, that we would like to hold in mind as we move onto discussing the accompanying neuroimaging research.

Neuroimaging Research Framework

Overview

The audience research revealed differences in how participants reported the experience of watching live performance of the same dance with different soundscapes. We used these qualitative results to shape our neuroimaging research on participants who watched a recording of the same performance while being scanned. Following Dimoka (2012), brain activity was revealed by functional Magnetic Resonance Imaging (fMRI). Results were analysed using a data-driven technique of Intersubject Correlation (ISC). ISC finds brain regions which have correlated activity across a group of observers, and this provides an indication of brain processes that are common in experiencing a stimulus as it unfolds in time (Hasson, Malach, & Heeger, 2010; Hasson, Nir, Levy, Fuhrmann, & Malach, 2004; Jääskeläinen et al., 2008; Kauppi, 2010; Kauppi, Pajula, & Tohka, 2014; Pajula, Kauppi, & Tohka, 2012). Because of the sensitivity of the method to common activity we would not expect individual aspects to be revealed. Thus comparison of ISC to audience research is limited to aspects of common group experience.

Given the limitation that ISC is sensitive to differences revealed in a group of observers, and that the audience research did not reveal substantial group differences between the two music conditions, we limited the neuroimaging research to examine only the Breath and Bach dance conditions. The rationale for this choice was that regardless of the type of observer (i.e. experienced or novice), reports of participants in the Breath condition indicated that the breath sounds punctuated the dance performance. This was in clear contrast to the Bach segment, which was distinctive in reports of a flowing experience. Of interest here is how these different subjective experiences would correspond to maps of ISC activity. One prediction, informed by the audience research, was that the punctuated nature of the breathing and footfalls would provide a consistent body-based signal for brain activity to synchronize and thus generate ISC. Another prediction was that the flowing nature of the Bach soundscape would lead to ISC as the brain activity entrained to the musical signal. We thus expected the ISC results to reveal activity consistent with these predictions. For example, we expected the subjective reports of body awareness while watching the Breath condition to correspond to evidence of activity in sensorimotor brain regions.

In addition to predictions arising from the audience research, recent reviews of the neuroaesthetics of dance (Cross & Ticini, 2012; Bläsing et al., 2012; Christensen & Calvo-Merino, 2013) provide insight into what ISC results to expect. Although recent research focuses on dance segments of only a few seconds duration, there is a growing literature on the brain mechanisms involved with watching dance, which includes discussion of the aspects of dance that make its aesthetic appreciation unique. An early experimental study examining the neuroaesthetics of dance related observers' subjective aesthetic responses to brain activity, and revealed higher ratings of liking and stronger modulation of activity in aesthetic related areas for high-speed movements with a high level of vertical displacement (Calvo-Merino, Jola, Glaser, & Haggard, 2008). Another fMRI study by Cross, Kirsch, Ticini, and Schütz-Bosbach (2011) related both liking a movement and the ability to perform a movement to brain activity. Their study also revealed that the more physically difficult a movement was to perform, the more it was enjoyed. While these studies implicate temporal features when processing the aesthetics of dance, a study by Calvo-Merino, Urgesi, Orgs, Aglioti, and Haggard (2010) demonstrated that viewing static dance postures also involves brain regions associated with aesthetic processing. In their review of these studies, Christensen and Calvo-Merino (2013) find support for four different brain regions in the aesthetic processing of dance. These include the ventral premotor cortex (BA6), medial and superior regions of the posterior occipital cortex (BA18, BA19), the inferior parietal cortex (BA 39/40) and the occipitotemporal cortex (BA37). We could expect that similar regions would be active in our ISC results, since the several minutes of dance used in the current study would contain brief events that produce similar aesthetic responses in the brain and lead to correlated brain activity. Moreover, given the evidence of more robust brain activity when viewing extended sequences of activity as opposed to brief and discrete events (Bartels & Zeki, 2004; 2005), we might expect additional brain areas to be revealed.

There is limited neuroimaging research exploring brain activity while participants watch performances. While some work has explored brain activity while watching dance solos of several minutes (Grosbras, Tan, & Pollick, 2012; Jola, Abedian-Amiri, Kuppuswamy, Pollick, & Grosbras, 2012; Jola et al., 2013; Noble et al., 2014) or even an entire two hour ballet (Jola, Pollick & Grosbras, 2011), the current study is unique in studying the same dance coupled with different soundscapes. Related work of Jola et al. (2013) using ISC indicates that combining music with dance will enhance the correlation of brain activity across observers in primary visual and auditory regions compared with just watching the dance without music. A recent ISC study examining brain activity while listening to 10 minutes of baroque symphony music (Abrams et al., 2013) has shown correlations in the primary auditory cortex and in the superior temporal cortex, extending into the angular and supramarginal gyrus as well as into the frontal cortex (Brodmann Areas 44, 45 and 47). These previous ISC studies indicate that audiovisual dance stimuli will produce ISC in auditory and visual areas, and that classical music on its own will produce ISC in auditory regions. While it is difficult to generalise from these previous ISC results to predict what differences will be found between the different soundscape conditions of Breath and Bach, we can expect the data-driven ISC method to reveal any differences in the mode in which these stimuli are processed.

In summary, expectations from the data-driven ISC analysis comparing the Breath to Bach conditions arise from (a) the results of the audience research; (b) neuroimaging studies that have examined brain response to brief stimuli with an aesthetic intent; and (c) other neuroimaging experiments that have used ISC to examine brain response to music and dance. While the previous neuroimaging literature informs general predictions about a possible aesthetic response to the performances, it is the audience research which informs more specific hypotheses about what differences will exist in the ISC maps for the Breath and Bach conditions.

Methods

Participants

A total of 22 participants (9 females) with an average age of 23.3 years were recruited to view the dance videos while being scanned. None of these participants had been exposed to the live performance. In contrast with the live performance, where some of the spectators were experienced dancers, this group of participants had minimal experience of performing dance. A total of 19 of the 22 participants had no experience with training in any kind of dance; two participants had less than a year of social dance and one participant had less than

6 months of contemporary dance lessons (but this was over four years prior to the experiment). The choice of only inexperienced dance observers differed from that used in the audience research, but was based on consideration of the finding that the observed differences between the Breath and Bach conditions appeared to be independent of the observers' level of experience. This element of the study was approved by the Ethics Committee of the Faculty of Information and Mathematical Sciences, University of Glasgow. All subjects gave their written informed consent prior to inclusion in the study.

Stimuli and Procedure

The stimuli were based on a high definition video recording of the *Double Points: 3X* dance that was obtained shortly before the live performance that formed the basis of the audience research. Although *Double Points: 3X* live had a fixed order of performance, the video recording was edited into sections of the dance with the different soundscapes. This provided both a Breath and a Bach dance section that were converted into AVI format. The order of these two dance sections (Breath, Bach) was counterbalanced across the participants. The dance with Bach soundscape had a duration of 304 seconds, and the dance with Breath soundscape had a duration of 341 seconds. Since these durations were unequal, and comparison of conditions would benefit from comparing sequences of equal length, we chose to analyse the entire Bach soundscape condition and the first 304 seconds of the Breath soundscape condition.

During each individual scanning session, participants lay supine in the scanner and viewed the display on a mirror that reflected images projected down the bore of the scanner. The projected display was reflected so that it would appear in the proper orientation when viewed in the mirror. Audio of the soundscape was provided by Nordic NeuroLab headphones with a sound intensity of 85 dB. The control of these displays was obtained using the software package Presentation (Neurobehavioral Systems). Participants were not given any response task while in the scanner, and were asked simply to watch and listen to the dance performance.

Data Aquisition

All fMRI data were collected using a 3T Tim Trio Siemens scanner (Erlangen, Germany). A high-resolution T1-weighted anatomical scan was conducted using a 3D magnetization prepared rapid acquisition gradient recalled echo (MP-RAGE) T1-weighted sequence (192 slices; 1mm cube isovoxel; Sagittal Slice; TR = 1900ms; TE = 2.52; 256x256 image resolution). The functional data were obtained from a single functional run (EPI, TR 2000ms; TE 30ms; 32 Slices; 3^3mm voxel; FOV of 210, imaging matrix of 70x70). This run lasted 816 sec (408 volumes) and followed the order of a fixation screen (10 seconds), the properly counterbalanced dance video of 795 seconds, and then a second fixation screen (10 seconds). For analysis, 152 volumes of the entire section of dance accompanied by Bach, and the first 152 volumes of dance accompanied by Breath were used for analysis.

The fMRI data were preprocessed using the fMRI pre-processing tools in Brain Voyager QX (Vers.2.1, Brain Innovation B.V., Maastricht, Netherlands), which involved 3D Motion Correction with Trilinear/sinc interpolation, and a High-Pass filter with a cutoff of 0.005 Hz. This was followed by normalization of functional scans into the common Talairach space (Talairach & Tournoux, 1988), and coregistration of functional and anatomical data into volume-time course-files (VTCs). Spatial smoothing with a Gaussian kernel of 6mm (FWHM) was applied to the created VTCs of each participant. Finally, the two 152 volume periods corresponding to the Bach and Breath sections of the run were extracted using Matlab.

Data Analysis

Analysis of the data was performed using the techniques developed by Kauppi and colleagues (Kauppi, Jääskeläinen, Sams, & Tohka, 2010; Pajula, et al., 2012; Kauppi et al., 2014). Kauppi et al. (2010) investigated frequency-specific inter-subject correlation (ISC) maps in an experiment where participants watched a single movie. Here, the same methodology was used across the full frequency-band to investigate ISCs within individual stimulus conditions (Bach, Breath) and differences in ISCs between the stimulus conditions. The analysis was performed using a Matlab-based ISC toolbox, which is freely available at http://code.google.com/p/isc-toolbox/. As a result of the analysis, two types of statistical maps were obtained: 1) maps showing condition-specific ISCs obtained from a single stimulus condition, and 2) maps showing the differences in ISCs between the two stimulus conditions.

The analysis followed the same principles as presented in Kauppi et al. (2010). An ISC test statistic was derived by computing Pearson's correlation coefficient voxel-wise across the time-courses of every possible subject pair and then averaging the result:

$$\bar{r} = \frac{1}{m(m-1)/2} \sum_{i=1}^{m} \sum_{j=2, j>i}^{m} r_{ij} ,$$

where m is the number of subjects and r_{ij} denotes the sample correlation coefficient between the time-courses of subject i and subject j. Note that because there were m = 22 subjects in the study, as many as 231 subject pairs needed to be averaged. Standard parametric statistical inference approaches are not valid for this test statistic due to the dependency of the correlation coefficients. Therefore, a fully nonparametric resampling-based bootstrap test was conducted against the null hypothesis that the test statistic would be the same as for unstructured data, which would be expected if there was no ISC present. An approximate "null" bootstrap distribution was generated by calculating the test statistic after circularly shifting each subject's time-series by a random amount so that they were no longer aligned in time across the subjects. Altogether 10 million bootstrap resamples were drawn by randomizing the experiment over all brain voxels and shifting points. The *p*-values were corrected using non-parametric False Discovery Rate (FDR) based multiple comparisons correction at the level q = 0.001 (Benjamini & Hochberg, 1995; Nichols & Hayasaka, 2003). The correction was performed voxel-wise over the whole brain. The corrected values of the test statistic were used to threshold the two computed ISC maps, one corresponding to *Bach* and one to *Breath*.

The difference maps were computed using the same test statistic as presented in Kauppi et al. (2010). First, a modified Pearson-Filon statistic based on Fisher's *z* transformation (ZPF) (Raghunathan, Rosenthal, & Rubin, 1996) was computed voxel-wise between every subject pair:

$$ZPF_{ij}^{BaBr} = \frac{(z_{ij}^{Ba} - z_{ij}^{Br})\sqrt{(N-3)/2}}{\sqrt{1-\mathrm{cov}(r_{ij}^{Ba}, r_{ij}^{Br}) / \{(1-(r_{ij}^{Ba})^2)(1-(r_{ij}^{Br})^2)\}}} ,$$

where $N = 152$ is the number of time-points, z is the Fisher's z transformed sample correlation coefficient, and superscripts *Ba* and *Br* denote the conditions *Bach* and *Breath*, respectively. The formula for large-scale covariance $\mathrm{cov}(r_{ij}^{Ba}, r_{ij}^{Br})$ can be found, e.g., in Raghunathan et al. (1996). The ZPF statistic is a recommended test statistic for testing if two non-overlapping but dependent correlation coefficients are different (Raghunathan et al., 1996). In this study, the assumption of dependent correlation coefficients across the conditions was made because the same dance performance was presented in both video clips. The group-level test statistic for the difference maps was obtained by combining pairwise statistics for all subject pairs:

$$ZPF_{\Sigma}^{BaBr} = \sum_{i=1}^{m} \sum_{j=1, j>i}^{m} ZPF_{ij}^{BaBr} . \qquad (1)$$

To threshold the difference maps, a nonparametric permutation test was performed under the null hypothesis that each ZPF value was drawn from a distribution with zero mean, which occurs when there is no difference in ISC between the two conditions. The approximate permutation distribution was generated by randomly flipping the sign of 231 pairwise ZPF_{ij}^{BaBr} statistics before calculating (1) using a subsample of 25,000 random labelings (out of 2^{231} possible labelings). Maximal and minimal statistics over the entire image corresponding to each labeling were saved to account for multiple comparisons by controlling familywise error rate (FWER). Due to symmetry of the distribution, thresholds for both ZPF_{ij}^{BaBr} (ISC significantly greater in *Bach*) and ZPF_{ij}^{BrBa} (ISC significantly greater in *Breath*) were obtained with this procedure. The threshold applied was p = 0.05, voxel-wise FWER-corrected for whole brain. See Kauppi et al. (2010) for a more detailed description of the above permutation test.

The calculation of the maps showing the ISC across the subjects during the stimulus and the maps showing the difference in ISC between the two stimulus conditions were calculated in Matlab and the results visualized in Brainvoyager. In this final step we also applied a cluster threshold of 108 mm^3.

Results

The brain areas where synchronized brain activity was found among the 22 participants for the Bach and the Breath conditions are shown in Table 2, and a visualisation of these results is presented in Figure 1. The brain areas with significantly greater synchronization across subjects in Bach versus Breath as well as Breath versus Bach are shown in Table 3, and a visualisation of these results is presented in Figure 2. An important point to note is that the tables report the precise location that had peak synchronization, but as can be seen in the tables and figures, a few of the regions are extensive and thus the anatomic labels provided in the tables for these regions of extensive synchronization should be interpreted with care. For example, in both the Bach and Breath conditions there was a large cluster with a peak in the visual cortex (BA 18 for Bach and BA17 for Breath) that extended substantially into the temporal lobes of both hemispheres.

From inspection of Figure 1 we can see that overlaying the synchronization for Bach (yellow) and Breath (purple) showed that although there were differences in their extent and spatial organisation, there was much overlap (brownish) between conditions. Moreover, this general pattern of overlap in synchronization was distributed throughout the brain. For both Bach and Breath, ISC was found to be significantly synchronized in visual and auditory regions on both sides of the cortex. This is most evident in Figure 1 at the horizontal sections of z=0 and z=10, as shown by the brownish colour which denotes an overlap of conditions. In addition there were regions of overlap in the bilateral parietal cortex that extended from the inferior to superior regions. Another area of overlap included bilateral regions of the dorsal premotor cortex (BA6). However an additional cluster of sychronization was found for the breath condition that extended from the dorsal to ventral premotor cortex (BA6) in the right hemisphere. A value of z=50 was used to delineate the boundary of the dorsal and ventral premotor cortex (Mayka, Corcos, Leurgans, & Vaillancourt, 2006). Finally there was extensive overlap in the bilateral superior temporal gyrus that extended to the border with the inferior parietal cortex.

The results of our statistical examination of how synchronization differed for the two conditions are presented in Table 3 and Figure 2. Locations where there was greater ISC for Bach than Breath are shown in red on Figure 2. These regions with greater ISC for Bach include the occipital cortex, including clusters in the right cuneus, left lingual gyrus and in a cluster that extended from the right lingual gyrus into the cerebellum. In addition to these clusters in the occipital cortex, there was a left hemisphere cluster in an anterior region of the superior temporal gyrus (Brodmann area 22). Locations where there was greater ISC for Breath than Bach are shown in blue on Figure 2. These regions with greater ISC for Breath include areas of the occipital, parietal and temporal cortices. In the occipital cortex, clusters were found in Brodmann areas 17, 18 and 19. In the parietal cortex there was a single cluster in Brodmann area 7. In the superior temporal gyrus there was bilateral activation in Brodmann area 22, as well as a cluster in left Brodmann area 41. Finally, there were bilateral clusters at the occipitotemporal junction in Brodmann area 37.

Discussion

The ISC analysis approach used in this study provides a measure of functional brain activity (Pajula et al., 2012), but it only captures activity that is common to the group of participants. Hence, the ISC analysis results inform us of what parts of the brain acted in synchrony across observers as they experienced the dance video individually in the scanner. This is important to emphasise since it does not fully reflect the situation in the live performance (i.e. where spectators share the experience in space and time). Moreover, greater correlation in ISC maps is a measure that does not strictly relate to the overall level of brain activity. For example, even if each individual participant had large changes in brain activation as a result of experiencing the video in the scanner, there could still be little to no synchronization found among the participants if each reacted in an idiosyncratic manner to the different events present in the stimulus material. Thus, the results of the single conditions reveal the neural activity common to experiencing each dance video separately, and the results comparing dance conditions reveal how this common activity differs between the dance conditions. This is interesting in relation to the audience research discussed above, which indicated widespread heightened responses to the Breath section – of it being more ‘physical’ and more ‘intense’ – but also provided a more varied evaluative assessments of whether this sense of physical intensity was enjoyed or not. In other words, we might argue that the common sensory experience was evaluated differently in terms of aesthetic preference. We will return to this comparison in the overall conclusion.

Examination of the single ISC maps revealed large regions of overlap for the two conditions, while the difference maps revealed distinct regions where the two conditions differed. The brain regions that were common to both the Breath and the Bach soundscape conditions included the primary visual and auditory areas. This is to be expected, since these regions encode the incoming sensory information and are generally found to respond to any auditory and visual stimulus (Hasson et al., 2010), including dance accompanied by music (Jola, et al., 2013). Other regions where ISC was found in both conditions extended past the primary sensory cortices into secondary auditory and visual processing regions, including those that have also been implicated in aesthetic processing whilst watching dance (Brodmann Areas, 19 and 37). In addition, both conditions yielded ISC maps in frontal and parietal regions, showing that synchronization can be obtained in areas involved in higher order processing of the dance stimuli. These regions included the parietal cortex as well as ventral and dorsal aspects of the premotor cortex (Brodmann Area 6). Activation in these parietal and premotor areas is commonly found in tasks involving action observation, and is thought to involve aspects of motor cognition. Additionally, the ventral premotor cortex (Brodmann Area 6) has been implicated in the aesthetic processing of dancem and thus the synchronization could reflect processing aesthetic aspects of the dance under both audio conditions.

As predicted from the audience research, differences in ISC results were found in statistical comparison of the Bach and Breath conditions. Clusters were found in the temporal cortex that were unique to the different audio conditions and indicated clear differences between the processing of the sound in the Bach and Breath conditions. Synchronization was greater in the left anterior portion of the superior temporal gyrus for the

Bach condition. Given that this brain region is widely known to process higher order properties of sound, this suggests that the participants were processing more complex structures of the audio signal while hearing Bach than during the Breath condition. This same region has also been reported by Abrams et al (2013) in ISC maps produced from listening to a baroque symphony. On the other hand, greater synchronization for Breath was found bilaterally in a more posterior region of the superior temporal gyrus which includes primary auditory cortex and is associated with the initial processing of auditory information. This suggests that the synchronization to Breath was driven by low-level auditory features, while the synchronization to Bach was driven by complex auditory features. Thus, our results show clear differences in the auditory processing of the different soundscapes. Moreover, the results of Jola et al. (2013) have shown that visual areas show greater synchronization when a dance is observed with music, and this suggests a role for auditory information in influencing visual processing. If this auditory processing were to drive the interpretation of the visual dance, then we might expect the Bach soundscape to impose a more complex and structured signal than that provided by breathing, resulting in increased ISC in visual areas. However, this is not what was found; instead greater ISC in auditory regions (Brodmann Areas 22 and 41) as well as visual areas (Brodmann Areas 17, 18 and 19) was found with the Breath soundscape than with the Bach soundscape. One possible reason for this is that the breathing sounds as well as the sound of the footfalls were synchronous with the motion of the body, and this audiovisual congruence could enhance the synchronization of visual areas. Whether these differences in audiovisual interactions of sound and dance could be a core cause of any difference in aesthetic processing of the dance is an open question, and a significant one that the dance neuroaesthetics literature is only beginning to address.

Comparison of synchronization between the Bach and Breath conditions also revealed clusters in the parietal cortex (Brodmann Area 7) and the boundary of the occipital and temporal cortices (Brodmann Area 37), where ISC was greater for Breath than Bach. The region in the postcentral gyrus of the parietal cortex (Brodmann Area 7) which showed greater ISC is known for simultaneously processing multiple sensory modalities, in particular the somesthetic modality that includes touch. This somesthetic connection implies a form of motor cognition, and could suggest that the Breath condition elicited greater engagement of action understanding within body-specific mechanisms. For example this could involve coding the viewed posture in a way that emphasised bodily attributes, such as the details of the posture and the relationship of the body to the sensory consequences of the dancers' actions. Consistent with the potential role of particular postures for the Breath condition is the finding of greater ISC in Breath than Bach in the occipitotemporal cortex (Brodmann Area 37). This region is close to the extrastriate body area (EBA) which is known to be activated when viewing body postures (Downing & Peelen, 2011) and has been implicated in the aesthetic processing of dance (Calvo-Merino et al., 2010). These findings of increased ISC among observers in the parietal cortex and occipitotemporal cortex (EBA) suggest a greater influence of the body when experiencing the Breath condition. Greater involvement of the body is consistent with embodied theories of cognition that stress the importance of motor cognition when interpreting actions and the possibility of mirror mechanisms (Rizzolatti & Sinigaglia, 2010), enabling sensory information to drive motor simulations of the actions being observed.

In summary, the results show both common and different brain processes related to watching dance with different soundscapes. Watching dance with either Bach or Breath sounds leads to synchronization across spectators in auditory and visual sensory areas along with in the parietal and frontal regions involved in motor cognition. Bach apparently provides a greater common experience regarding the complex structure of the music, something that is paralleled in the audience research where spectators described immersing themselves in the combined experience of dance and music. Meanwhile, Breath more readily engages the processing of sound along with a more embodied response involving multisensory areas in the parietal cortex, and body posture and motion sensitive regions in the occipitotemporal region. This more embodied response for breathing is something that was also evident in the audience research data. Finally, of the four main regions considered by Christensen and Calvo-Merino (2013) to be involved in aesthetic processing, we identified synchronization in all but the inferior parietal cortex. While finding synchronization in these implicated regions does not guarantee that the synchronization was being driven by cognitive aspects of an aesthetic interpretation rather than something else (such as physical properties of the dance), it does invite further studies using ISC analysis to explore these regions sensitive to dance aesthetics. These future studies will also help to further confirm the reliability of the fMRI signal while watching dance (Bennett & Miller, 2010).

Summary and Concluding Discussion

Rosenfield (1992) describes transdisciplinary research as involving "researchers working jointly using shared conceptual framework drawing together discipline-specific theories, concepts, and approaches to address a common problem" (p. 1351). In this study the transdisciplinary approach shaped the research in many ways. The utilisation of the two approaches in this research provided opportunities for each to inform the other in terms of what to look for and how to interpret potential findings. The chosen hypothesis for fMRI research was shaped to a significant degree by the insights that emerged from the qualitative audience research. Additionally, the neuroimaging technique employed (ISC) is a data driven approach. It provides some quantitative results about what the common brain response is to stimuli, but this then needs to be interpreted in the light of existing knowledge. The qualitative audience research informs this interpretation, enabling insights that can be matched to the ISC analysis.

A first interesting connection to pursue is in terms of spectator responses to the relationship between the Bach soundscape and the movement of the dance performance. Here the audience research revealed a greater perception of flow and grace and also a greater perception of synchronicity between music and movement than in the Breath soundscape. Some of the participants described this as providing an opportunity to immerse themselves in the experience, with there being almost no interpretative or perceptual gap between the movement and the music. This observation can be placed alongside the fMRI results that describe how during the Bach section there was greater synchronization in the anterior portions of the superior temporal gyrus than in the Breath section, suggesting that during this section participants were processing the complex structure of the audio signal in a manner that did not occur for the Breath section.

The audience research suggests that in discussing the Bach section, participants' perceptions were that the structures of the movement and the music were very much aligned. We might speculate that the pleasure derived from the Bach section emerged from a neurological pleasure in complex processing, the spectator in a sense being 'carried away' because the brain is pleasurably occupied with the task of simultaneously processing (and perhaps matching) two different visual and auditory codes. The qualitative audience research suggests that for some spectators, aesthetic pleasure is derived from finding convergences between these two processes of interpretation, in contrast with the displeasure that might be experienced through misalignment and failures to perceive synchronicity. It is thus possible that this greater convergence of audio and visual processing might somehow be related to the greater synchronization for Bach found in the cuneus and lingual gyrus (BA 18), but this requires further confirmation from future studies.

The second connection relates to the aesthetic experience of the Breath section. Here the fMRI evidence suggests that the Breath section more readily engaged the processing of sound along with a more embodied response involving multisensory areas in the parietal cortex and body sensitive areas in the occipitotemporal cortex. This description of a more embodied experience clearly correlates with the qualitative research, where audience members' self-reflective conversations demonstrated evidence of a similarly corporeally focused experience. The qualitative research revealed spectators reporting a heightened sense of both their own physicality and that of the performers during the Breath section. We interpreted this in terms of the Breath section triggering a shift from a predominantly visual mode of perception to experiencing a proprioceptive sensation or body to body effect.

This embodied response was something that the neuroimaging revealed as occurring across spectators, rather than being idiosyncratically limited to individuals. The audience research also found the perception of heightened physicality to be widespread in spectators' subjective reporting of the experience. At the same time, however, the audience research also revealed that the impact of this more corporeal sense of perception – that is, a greater sense of their own body, as well as that of the dancers – was articulated either negatively *or* positively by different spectators. Often the nature of the experience of the Breath section was described using very similar language, but the evaluation of whether this was pleasurable, and whether it was liked or disliked, was very different. For some spectators this proprioceptive or contagious body-to-body effect is an enjoyable, kinesthetic and empathetic element of their aesthetic appreciation of dance – and it is this kind of experience that they seek out when watching dance. In contrast, for other spectators these effects disrupt the visual experience and aesthetic appreciation of grace and flow – and in turn they seek out different, more ethereal kinds of dance performances. The evidence indicated by the qualitative audience research, along with the measurements provided by the neuroimaging data, indicates that hearing audible breathing as part of watching dance leads to increased embodiment for spectators, whether they enjoy it or not.

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Table 1

Details of the main four exercises undertaken in the workshops and their role as both data gathering and participatory analysis

	Activity	Meaning making & analysis
Exercise 1. Collecting memories (incidents).	Each participant was asked to relate something they remembered from the performance. The facilitators employed a set of open prompts to draw out more from these recollections, such as 'Can you tell me more about that?', 'And what did you think about that?' Once everybody had contributed a memory, the facilitator went round the group a second and third time, with participants asked to contribute further recollections that nobody had identified.	Gathering of raw memories (data).
Exercise 2. Sorting memories.	Working together, participants were asked to group memories under a set of categories, such as 'Things I saw', 'Things I heard', 'Things I felt and thought'. In this exercise participants were encouraged to work with each other to think about how to group memories and to aim to try and get everything written down.	Collaborative meaning making; an early stage of data analysis.
Exercise 3. Interrogating memories.	Working individually, participants were invited to select one memory that was particularly significant to them. Having been given a large sheet of paper containing a blank spider diagram, participants were asked to write their selected memory in the centre of the diagram and then spend time filling out the rest of the paper with connected memories, feelings, interpretations, and/or sensations. If they ran out of circles they were invited to add more. When each participant had finished, they were asked to talk through their diagram to the group, with members invited to ask each other questions or find comparisons between their responses.	Individual meaning making. Collaborative analysis.
Exercise 4. Collaborative dialogue.	An open discussion, drawing on the material developed during the workshop, and with a particular focus on the research question of the relationship between sound and movement. (Note: in all three workshops this theme had already figured prominently within the responses and materials developed in exercises 1 to 3.)	Collaborative meaning making and analysis.

Table 2

Results of the Intersubject Correlation Analysis for the two conditions

Condition	Anatomical region	Hemi-sphere	Talairach – coordinate (x,y,z)	BA	Peak Statistic	Volume (mm^3)
Bach	Middle Frontal Gyrus	Left	-22, -11, 60	6	0.094	1317
	Inferior Parietal Lobule	Left	-34, -50, 57	40	0.116	7793
	Superior Temporal Gyrus	Left	-55, -14, 6	22	0.123	6637
	Lingual Gyrus	Left	-10, -83, -6	18	0.276	114159
	Superior Parietal Lobule	Right	23, -53, 60	7	0.112	7508
	Precentral Gyrus	Right	26, -15, 57	6	0.057	247
	Superior Temporal Gyrus	Right	65, -20, 12	42	0.113	6073
	Fusiform Gyrus	Right	37, -47, -12	37	0.064	916
Breath	Superior Parietal Lobule	Left	-31, -50, 63	7	0.118	10144
	Middle Frontal Gyrus	Left	-22, -11, 54	6	0.065	985
	Cuneus	Left	-13, -86, 6	17	0.203	153029
	Parahippocampal Gyrus	Left	-22, -47, -6	37	0.065	277
	Fusiform Gyrus	Left	-43, -41, -15	37	0.062	282
	Superior Frontal Gyrus	Right	20, -8, 63	6	0.078	3523
	Precentral Gyrus	Right	47, -5, 51	6	0.054	512
	Superior Temporal Gyrus	Right	62, -26, 9	42	0.177	14949

Ntoe BA - Brodmann area

Table 3

Results showing where the comparison of the level of synchronization differed between the Bach and Breath conditions

Comparison of Conditions	Anatomical region	Hemi-sphere	Talairach – coordinate (x,y,z)	BA	Peak Statistic	Volume (mm^3)
Bach greater than Breath	Superior Temporal Gyrus	Left	-58, -8, 2	22	130.6	179
	Lingual Gyrus	Left	-10, -83, -6	18	191.8	1775
	Cuneus	Right	8, -89, 18	18	155.6	2101
	Culmen (cerebellum)	Right	8, -68, -6	NA	124.7	389
Breath greater than Bach	Superior Temporal Gyrus	Left	-65, -47, 12	22	118.2	280
	Superior Temporal Gyrus	Left	-46, -29, 9	41	253.1	2249
	Middle Temporal Gyrus	Left	-59, -68, 6	37	143.4	362
	Middle Occipital Gyrus	Left	-46, -77, 6	19	118.4	382
	Inferior Occipital Gyrus	Left	-25, -89, -2	18	129.1	150
	Postcentral Gyrus	Right	8, -56, 66	7	119.0	742
	Superior Temporal Gyrus	Right	59, -32, 15	22	223.3	3326
	Cuneus	Right	20, -92, 6	17	138.6	1184
	Middle Occipital Gyrus	Right	50, -71, 3	37	161.7	1535

Nŀe BA - Brodmann area

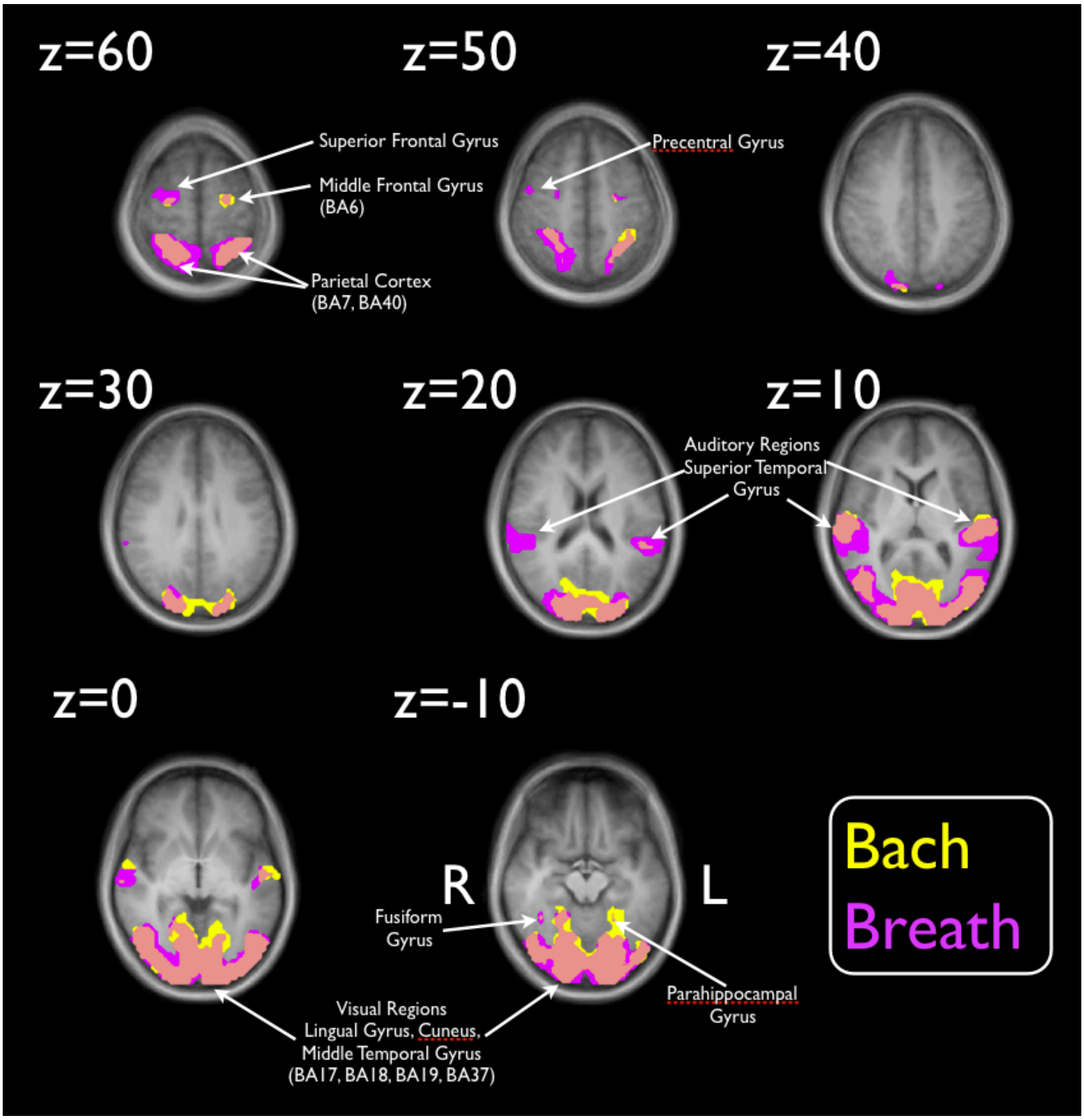

Figure 1. Results of the Intersubject Correlation Analysis on the 22 observers for the two different conditions of Bach (yellow) and Breath (purple) plotted on an average brain (an overlap of both conditions results in a brownish colour). The values of z correspond to the Talairach coordinate at which the horizontal slice was taken. Large overlap is seen in visual and auditory cortices for both conditions.

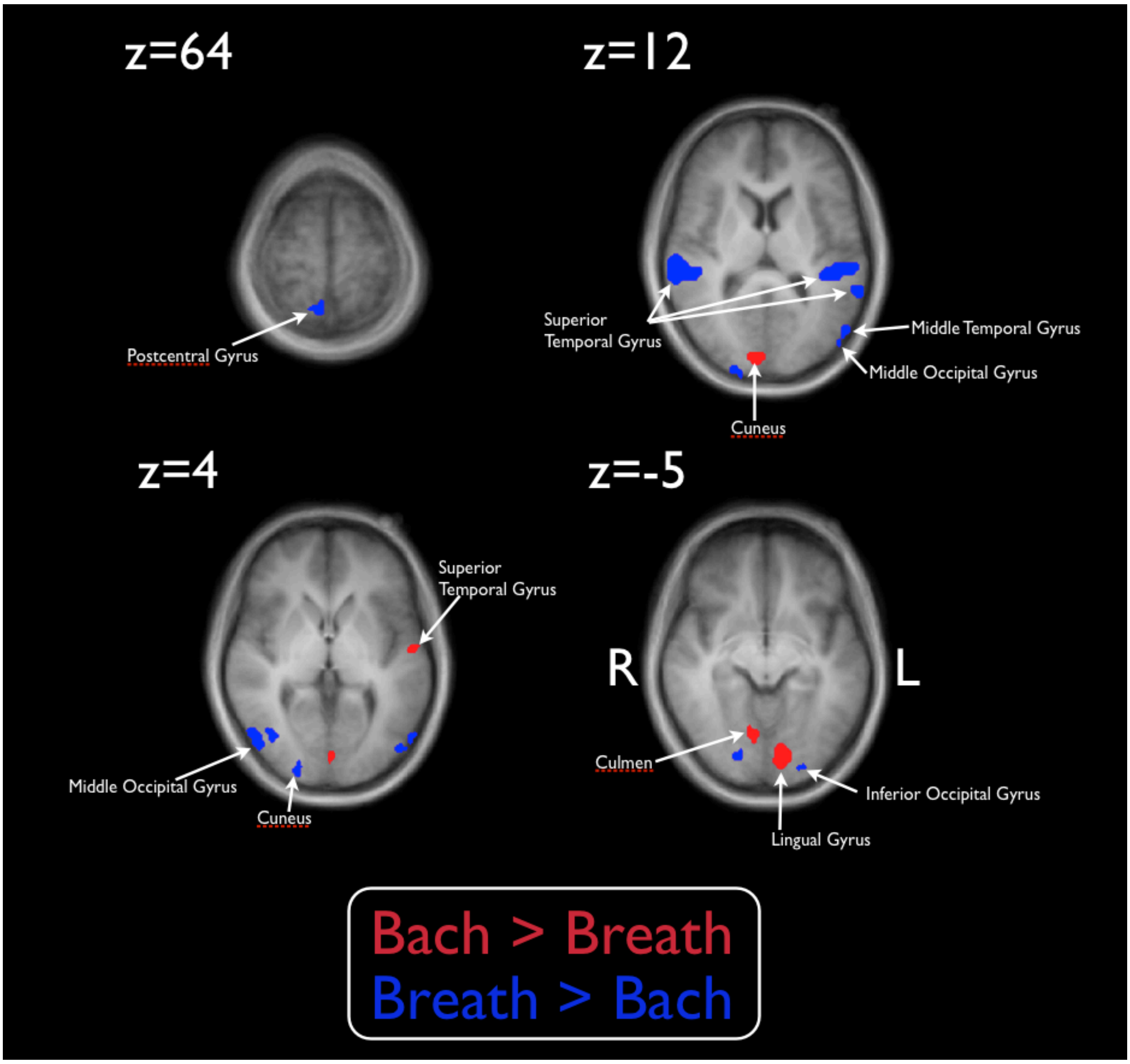

Figure 2. Results of the Intersubject Correlation Analysis on the 22 observers for the two comparisons of Bach greater than Breath (red) and Breath greater than Bach (blue) plotted on an average brain. The values of z correspond to the Talairach coordinate at which the horizontal slice was taken. Regions where Bach was greater than Breath are shown in the visual cortex and left anterior regions of the superior temporal gyrus. Regions where Breath were greater than Bach include the primary auditory cortex, the middle occipital cortex for the processing of body postures and motion, as well as Brodmann area 7 of the parietal cortex, which is associated with multimodal processing of sensory information, including somatosensation.