Proceedings of the 15th International Conference of
Students of Systematic Musicology (SysMus22)

Sponsors

GHENT
UNIVERSITY

FACULTY OF ARTS
AND PHILOSOPHY

CULTUUR
GENT

QUALISYS
Motion Capture Systems

ant neuro
inspiring technology

FACE

gent:

European
Society for the
Cognitive Sciences
Of
Music

sempre:

Society for Education, Music
and Psychology Research

BAVO
ANNO 1253
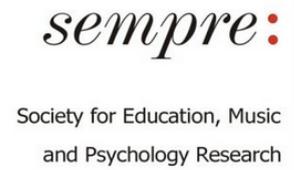
About SysMus

The SysMus conferences (International Conference of Students of Systematic Musicology) are annual student-run events designed to allow advanced students in the fields of systematic musicology and music science – particularly those studying for PhDs or completing Masters' degrees – to meet and discuss their research. Keynote speakers include internationally renowned researchers working in various sub-fields of systematic musicology and music science. SysMus is committed to incorporating a wide range of topics within its conferences, representative of the umbrella term "systematic musicology": music perception, music cognition, music psychology, music therapy, music modelling, music information retrieval, musical acoustics, music theory and analysis, music sociology, music education, music technology, music and culture, music and semiotics, and music philosophy.
In September 2022, Institute for Psychoacoustics and Electronic Music (IPEM) hosted SysMus22 at Ghent University in Belgium.

About Institute for Psychoacoustics and Electronic Music (IPEM)

Institute for Psychoacoustics and Electronic Music (IPEM) is a renowned research group in systematic musicology, focusing on embodied music cognition and expressive interaction with music. It holds a special position, as the institute finds its origins in electro-acoustic music production and has been at the forefront of music innovation ever since. Throughout the years, IPEM has not lost touch with these origins, providing its rare position of maintaining a truly interdisciplinary approach where knowledge of empirical research is not solely valued, but the expertise of engineers and artists is additionally seen as invaluable. The resulting in-house interdisciplinary methods are used in fields such as music education, rehabilitation, sports sciences, and the arts, and are based on music theory, performer-inspired analysis, advanced behavioural and neuroscientific empirical experiments, statistics, and computer modelling.

Organizing Committee
Kelsey Onderdijk (Chair)
Aleksandra Michałko (Co-Chair)
Bavo Van Kerrebroeck

Review Committee

Adrien Bardet	Giusy Caruso	Mattia Rosso
Adriaan Campo	Henry Drummond	Mimi O'Neill
Andres von Schnehen	Hugo Scurto	Philippe Esling
Anna Niemand	Ioulia Marouda	Pierre-Amaury Grumiaux
Axel Chemla-Romeu-Santos	Iza Korsmit	Sai Charan Kanagala
Benjamin Matuszewski	Jasmijn Lootens	Sandra Fortuna
Claudia Pulcini	Joren Six	Sarah Hashim
Dana Swarbrick	Jorg De Winne	Simin Yang
Edoardo Passarotto	Lionel Newman	Steffen Herff
Elif Canseza Kaplan	Lousin Moumddjian	Tomomi Hida
Emma Allingham	Marc Vidal	Umut Eldem
Fleur Hubau	Mariëlle Baelemans	Xuan Huang

TABLE OF CONTENTS

ORAL PRESENTATIONS

ORAL PRESENTATIONS

WORKSHOPS

DEMOS

Abstracts are listed alphabetically per category, i.e., oral presentations, poster presentations, workshops, and demos.
The names of researchers who presented during the conference are underlined in the abstracts.
If you want to access the ORCID iD of a researcher, click on his/her name.

ORAL PRESENTATIONS

Novelty in the brain's reward network: An fMRI investigation into the neural correlates of music-induced feelings of novelty

Ceren Ayyildiz[1], Caroline Harbison[1,2], Diana Omigie[1]

[1]Goldsmiths, University of London, London, United Kingdom.

[2]University of Oxford, Oxford, United Kingdom

BACKGROUND

Novelty can act as an intrinsic reward (Düzel et al., 2010), motivate exploratory behaviour (Silvia et al., 2009; Schomaker & Meeter, 2015), and increase learning and memory (Davis et al., 2004). The detection of novelty is thought to induce feelings of reward through modulation of the dopaminergic system, including frontal regions in the brain (Berns et al., 1997; Bunzeck et al., 2011). Music has also been shown to activate these regions, notably during predictive processing. Errors in prediction during music listening can lead to feelings of surprise and reward, with accompanying activation in brain regions such as the nucleus accumbens (NAc) and inferior frontal gyrus (IFG), areas also implicated in the experience of novelty (Koelsch et al., 2005; Omigie et al., 2013; Salimpoor et al., 2013). Taken together, findings to date suggest a role for novelty in music's ability to produce feelings of reward. However, the neural correlates of music-induced novelty have not yet been explored.

AIMS

We aimed to investigate the neural correlates of music-induced novelty through analysis of a pre-established fMRI dataset. We also aimed to investigate the acoustic properties associated with feelings of novelty, in addition to the relationship between subjective ratings of pleasantness and predictability and the experience of novelty during music listening.

METHOD

The musical stimuli used during the experiment were adapted from Levitin and Menon's (2003) music-shuffling paradigm. Acoustic features of these excerpts were extracted using the MIR toolbox in MATLAB (Lartillot & Toiviainen, 2007) and correlated with behavioural and neural data. Whole-brain and regions of interest analyses were carried out in FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl).

RESULTS

Music-induced novelty was associated with changes in acoustic features, subjective ratings and activations in the frontal and temporal cortices. Regions of interest (ROI) analyses revealed that novelty-sensitive regions, including the NAc, inferior frontal gyrus, insula, anterior cingulate gyrus, precentral gyrus, and posterior division of the superior temporal gyrus, reliably tracked the time-course of novelty during music listening (although the substantia nigra/ventral tegmental area, a region repeatedly highlighted in the literature (Davis et al., 2004; Bunzeck et al., 2011). Novelty-related activations in reward and auditory areas, such as the medial frontal cortex and superior frontal gyrus, were significantly higher among individuals who experienced greater subjective pleasantness during music listening than those who experienced lower subjective pleasantness.

DISCUSSION

This study provided the first direct link between novelty detection and the neural substrates of pleasure in music listening. The finding that previously identified novelty-sensitive regions, such as the NAcc and IFG (Kiehl et al., 2001a; Bunzeck et al., 2011), track the time-course of novelty during music listening suggests that not only does music elicit feelings of novelty akin to non-musical stimuli, but that music could be widely used as a tool to study the neural correlates of novelty and reward. Future directions include a psychophysiological interaction analysis to assess functional connectivity between novelty-responsive regions during music listening.

REFERENCES

Berns, G. S., Cohen, J. D., & Mintun, M. A. (1997). Brain regions responsive to novelty in the absence of awareness. *Science, 276*(5316), 1272-1275. https://doi.org/10.1126/science.276.5316.1272

Bunzeck, N., Guitart-Masip, M., Dolan, R. J., & Düzel, E. (2011). Contextual novelty modulates the neural dynamics of reward anticipation. *Journal of Neuroscience, 31*(36), 12816-12822.

Davis, C. D., Jones, F. L., & Derrick, B. E. (2004). Novel environments enhance the induction and maintenance of long-term potentiation in the dentate gyrus. *Journal of Neuroscience, 24*(29), 6497-6506.

Düzel, E., Bunzeck, N., Guitart-Masip, M., & Düzel, S. (2010). Novelty-related motivation of anticipation and exploration by dopamine (NOMAD): Implications for healthy aging. *Neuroscience & Biobehavioral Reviews, 34*(5), 660-669. https://doi.org/10.1016/j.neubiorev.2009.08.006

Kiehl, K. A., Laurens, K. R., Duty, T. L., Forster, B. B., & Liddle, P. F. (2001). An event-related fMRI study of visual and auditory oddball tasks. *Journal of Psychophysiology, 15*(4), 221-240.

Koelsch, S., Fritz, T., Schulze, K., Alsop, D., & Schlaug, G. (2005). Adults and children processing music: An fMRI study. *NeuroImage, 25*(4), 1068-1076. https://doi.org/10.1016/j.neuroimage.2004.12.050

Lartillot, O., & Toiviainen, P. (2007). *MIR in MATLAB (II): A toolbox for musical feature extraction from audio*. International Conference on Music Information Retrieval, Vienna, Austria.

Levitin, D., & Menon, V. (2003). Musical structure is processed in "language" areas of the brain: A possible role for Brodmann area 47 in temporal coherence. *NeuroImage, 20*(4), 2142-2152.

Omigie, D., Pearce, M. T., Williamson, V. J., & Stewart, L. (2013). Electrophysiological correlates of melodic processing in congenital amusia. *Neuropsychologia, 51*(9), 1749-1762.

Salimpoor, V. N., Van den Bosch, I., Kovacevic, N., McIntosh, A. R., Dagher, A., & Zatorre, R. J. (2013). Interactions between the nucleus accumbens and auditory cortices predict music reward value. *Science, 340*(6129), 216-219. https://doi.org/10.1126/science.1231059

Schomaker, J., & Meeter, M. (2015). Short- and long-lasting consequences of novelty, deviance and surprise on brain and cognition. *Neuroscience & Biobehavioral Reviews, 55*, 268-279.

Silvia, P. J., Nusbaum, E. C., Berg, C., Martin, C., & O'Connor, A. (2009). Openness to experience, plasticity, and creativity: Exploring lower-order, high-order, and interactive effects. *Journal of Research in Personality, 43*(6), 1087-1090. https://doi.org/10.1016/j.jrp.2009.04.015

The relationship between groove and catchiness in popular music patterns

Toni A. Bechtold[1,2], Maria A. G. Witek[1]
[1]University of Birmingham, Birmingham, United Kingdom.
[2]Lucerne University of Applied Sciences and Arts, Lucerne, Switzerland

BACKGROUND

Groove and Catchiness are two central characteristics of popular music that frequently appear together. In music psychology, groove is commonly understood as pleasurable urge to move. Definitions of catchiness are sparse and elusive, with the consensus being that it is connected to the memorability of music. A possible relationship between groove and catchiness has not been postulated or examined before the start of this project. Previously, we conducted a study using expert interviews in which we established a theory about mutual support and positive interaction between groove and catchiness. In this study, we are examining this relationship with quantitative methods in a listening experiment with non-expert participants.

AIMS

We aim to investigate whether and how groove and catchiness are related.

METHOD

We conducted a 3-part listening experiment with 450 participants for which we composed 240 8-bar popular music patterns (80 each of Drums, Bass, and Keyboards). In part 1 of the experiment, participants heard 16 of these clips while performing a search task. Part 2 presented 16 clips and participants were asked whether they recognised them from part 1 (8 were repeated from Part 1). They rated them either with the Experience of Groove Questionnaire (Senn et al., 2020) or an ad-hoc catchiness questionnaire with 4 items (catchiness, memorability, attention, and distinctiveness). Part 3 presented the same music as part 2 but with the respective other questionnaire. We collected background information about the listener, such as their musical taste and expertise, and structural information on the stimuli via musicological analysis, music information retrieval, and other established measures. We analysed the data with Bayesian mixed effects regression models.

RESULTS

Music rated high on catchiness had a higher chance to be recognized (β = 0.37, SE = 0.03, 95% CrI [0.32, 0.43], R^2_m = 0.04) but a correct recognition does not explain much of the catchiness ratings (β = 0.26, SE = 0.03, 95% CrI [0.20, 0.32], R^2_m = 0.04).

The Catchiness ratings predicted the Urge to Move ratings well (β = 0.47, SE = 0.02, 95% CrI [0.44, 0.51], R^2_m = 0.42), and vice versa (β = 0.50, SE = 0.02, 95% CrI [0.46, 0.53], R^2_m = 0.43). In general, we found similarities as to which variables influence groove and catchiness and in which direction. Listener-related variables (e.g., musical taste) and listeners' responses towards a stimulus (e.g., perceived complexity, familiarity) showed much stronger effects than stimulus-related variables.

DISCUSSION

We suggest that catchier music is easier to recognize, but that catchiness has more to it than memorability. The subordination of stimuli-related variables suggest that it depends, like groove, mostly on the listener. The positive relationship between groove and catchiness strengthens our theory that they support each other. Further, our results demonstrate that similar factors contribute to determining why music is groovy or catchy to us, individually.

REFERENCES

Senn, O., Bechtold, T., Rose, D., Câmara, G. S., Düvel, N., Jerjen, R., … Alessandri, E. (2020). Experience of groove questionnaire: Instrument development and initial validation. *Music Perception*, 38(1), 46–65. https://doi.org/10.1525/mp.2020.38.1.46

Bechtold, T. A., Witek, M. A. G., & Curry, B. (in review). The catchiness of groove: How popular music creators understand groove and catchiness. *Music Perception*.

Exploring the potential of augmented reality (AR) in instrumental music learning

Adriaan Campo†[1], Aleksandra Michałko†[1], Boris Stajic[2], Bavo Van Kerrebroeck[1], Maja Pokric[2], Marc Leman[1]

[1]Ghent University, Ghent, Belgium.
[2]ARVRtech, Novi Sad, Serbia

BACKGROUND

Researchers increasingly explore the potential of mixed-reality (MR) environments in instrumental music learning (Johnson et al., 2020). For instance, MR has been used to create a variety of concert scenarios that have been used in studies of musicians' performance anxiety (Bissonnette et al., 2015). However, the effectiveness of augmented reality in orchestra training is still underexplored.

AIMS

The aim of this study is two-fold: 1) to investigate augmented reality (AR) as an effective tool in enhancing performance quality of amateur violin players 2) to obtain players' feedback on learning within AR environments.

METHOD

Eleven amateur violin players (6 first violins, 5 second violins; 6 females, 5 males; M age = 21.27, SD age = 2.24) rehearsed two orchestral excerpts with a virtual audiovisual rendering of a concertmaster within an AR environment. Violin players were randomly divided into two groups: 1) Rehearsing with a 3D avatar on the first excerpt and 2D video on the second excerpt (3D/2D), 2) Rehearsing with a 2D video on the first excerpt and 3D avatar on the second excerpt (2D/3D). The violinists participated in 4 sessions (one session per week) in which they practised each excerpt for 20 minutes in randomised order. We recorded audio, video and movement data (with Qualysis motion tracking system) to measure performance quality. In addition, we collected data about the violinists' feelings on immersion, social and physical presence, performance quality, and experience of the application's interface using standardised questionnaires (Makransky et al., 2017; Witmer et al., 2005), as well as open-ended questions. These qualitative and quantitative data were compared within and between subjects.

RESULTS

A preliminary analysis of movement data and questionnaires suggests a significant difference between 3D and 2D conditions within and between subjects. Participants played more accurately with the avatar in the 3D condition independently from the group, the excerpt, and the session number. Analysis of questionnaire data suggests all participants favoured rehearsals with 3D avatar independently from the aforementioned factors. Furthermore, there were significant differences between the 3D and 2D conditions regarding participants' judgements of social and physical presence as well as the interfaces of the AR environments. In relation to 3D avatar condition, 50% of participants responded neutral or positively to a seven-point Likert scale inquiring "how similar the experience was to be practicing with your colleague?" (Mdn = 4, IQR = 2). As one participant noted: "It is still not the same, although a good alternative."

Suggestions for application improvement include the possibility to incorporate audio of the orchestra, the possibility to play in different tempi (especially difficult passages), and the generation of audio feedback (in form of verbal comments) or visual feedback on the performance quality.

DISCUSSION

Amateur and beginner musicians need more assistance and guidance during their practice sessions than professional musicians. Therefore, receiving regular feedback and partaking in weekly orchestra rehearsals is crucial for their musical development. Hence, AR training might be a valuable addition to traditional instrumental training when attending orchestra rehearsals is not possible. This need has been highlighted by the recent COVID pandemic and the ensuing closure of all musical and group activities. This study presents the evaluation of an AR environment for instrumental music training and offers insights to improve interface design and feedback options in such applications (Bian, 2016).

REFERENCES

Bian, H. X. (2016). Application of virtual reality in music teaching system. *International Journal of Emerging Technologies in Learning (iJET), 11*(11), 21-25.

Bissonnette, J., Dubé, F., Provencher, M. D., & Moreno Sala, M. T. (2015). Virtual reality exposure training for musicians: Its effect on performance anxiety and quality. *Medical Problems of Performing Artists, 30*(3), 169-177.

Johnson, D., Damian, D., & Tzanetakis, G. (2020). Evaluating the effectiveness of mixed reality music instrument learning with the theremin. *Virtual Reality, 24*(2), 303-317.

Makransky, G., Lilleholt, L., & Aaby, A. (2017). Development and validation of the multimodal presence scale for virtual reality environments: A confirmatory factor analysis and item response theory approach. *Computers in Human Behavior, 72*, 276-285.

Witmer, B. G., Jerome, C. J., & Singer, M. J. (2005). The factor structure of the presence questionnaire. *Presence, 14*(3), 298-312.

ERP indices of emotion comprehension in music & visual art

Francesco De Benedetto[1,2], Alice M. Proverbio[1,2]

[1]University of Milano - Bicocca, Milan, Italy.

[2]Neuro-Mi, Milan, Italy

BACKGROUND

A line of research has related music with other sensory domains and has used background music to investigate the modulation of concurrent mental processes. Baumgartner and colleagues found that music was able to enhance the emotional experience evoked by the affective pictures, when congruently combined (Baumgartner et al., 2006). Also, Jeong et al. (2011) showed how emotional congruence across sensory modalities would enhance activity in auditory regions.

AIMS

With the present work, we aimed at investigating how the emotional content of music affects the perception of emotional feelings experienced during artwork perception. We hypothesised that emotionally incongruent music would negatively affect the emotional comprehension of the visual stimulus. In addition, we expected congruent stimuli to be more pleasant than incongruent ones. We awaited the LP component to reflect the experienced pleasantness as it is modulated by the arousal of the stimulus (Cuthbert et al., 2000).

METHODS

We presented 18 university students with pairs of paintings and musical excerpts with either congruent or incongruent emotional content. Emotional categories were the same for both visual and auditory stimuli: positive (happiness, relax) and negative (fear, sadness). The stimuli emotional connotation was preliminary validated. Based on the validation, we selected 48 artworks and 5 musical pieces per category to be used in the EEG/ERP recording. We measured the mean amplitude of visual N170 (150-180 ms) and Late Positive Potential (LPP, 800-1000 ms), acoustic N400 (400-500 ms), and multimodal Late Positivity (LP, 700-900 ms).

RESULTS

Both N170 ($p < .05$) and LPP ($p < .01$) were greater in response to positive artworks, as compared to negative ones. N400 showed greater amplitude ($p < .05$) in response to negative auditory stimuli than positive ones.

The ANOVA performed on LP amplitude values showed a significant effect ($p < .01$) of the congruency factor (congruent positive, congruent negative, incongruent) with greater values in response to congruent and positive stimuli, as compared to congruent but negative, or incongruent stimuli. swLORETA source reconstructions were performed in the LP time-window in response to the different type of stimuli (positive and negative art, positive and negative music). In all four conditions, the common activation of the left MFG (BA10), the left SFG (BA8), and right MTG (BA21) were highlighted.

DISCUSSION

Our results show that N170 reflects not only physical characteristic of the stimulus and attentional processes, but also emotional valence. The LPP results are in line with the literature, as it is modulated by the arousal of the stimuli (Cuthbert et al., 2000). Besides, the N400 results are in line with what previous studies found comparing stimuli with different valence. As LP component is known to index pleasantness of the stimulation (van Peer et al., 2014), we suggest that congruent negative pairs were less pleasurable than incongruent ones. In all conditions, the most active areas were left MFG and SFG, right Precuneus, and right MTG. All these areas were found to contribute to the aesthetic experience (Cattaneo et al., 2014, 2014b). To conclude, our results showed the interaction and integration of the two sensory modalities.

REFERENCES

Baumgartner, T., Esslen, M., & Jäncke, L. (2006). From emotion perception to emotion experience: Emotions evoked by pictures and classical music. *International Journal of Psychophysiology*, 60(1), 34–43.

Cattaneo, Z., Lega, C., Flexas, A., Nadal, M., Munar, E., & Cela-Conde, C. J. (2014). The world can look better: Enhancing beauty experience with brain stimulation. *Social Cognitive and Affective Neuroscience*, 9(11), 1713–1721.

Cattaneo, Z., Lega, C., Gardelli, C., Merabet, L. B., Cela-Conde, C. J., & Nadal, M. (2014). The role of prefrontal and parietal cortices in esthetic appreciation of representational and abstract art: A TMS study. *NeuroImage*, 99, 443–450. https://doi.org/10.1016/j.neuroimage.2014.05.037

Cuthbert, B. N., Schupp, H. T., Margaret M., B., Niels, B., & Lang, P. J. (2000). Brain potentials in affective picture processing: covariation with autonomic arousal and affective report. *Biological Psychology*, 52, 95–111.

Jeong, J. W., Diwadkar, V. A., Chugani, C. D., Sinsoongsud, P., Muzik, O., Behen, … Chugani, D. C. (2011). Congruence of happy and sad emotion in music and faces modifies cortical audiovisual activation. *NeuroImage,* 54(4), 2973–2982. https://doi.org/10.1016/j.neuroimage.2010.11.017

van Peer, J. M., Grandjean, D., & Scherer, K. R. (2014). Sequential unfolding of appraisals: EEG evidence for the interaction of novelty and pleasantness. *Emotion*, 14(1), 51–63. https://doi.org/10.1037/a0034566

Neural mechanisms of recognition memory for auditory sequences of varying complexity

<u>Gemma Fernández Rubio</u>[1,2], Elvira Brattico[1,3], Sonja A. Kotz[2], Morten L. Kringelbach[1,4,5], Peter Vuust[1], Leonardo Bonetti[1,4,5]

[1]Center for Music in the Brain, Department of Clinical Medicine, Aarhus University and The Royal Academy of Music, Aarhus, Aalborg, Denmark.

[2]Faculty of Psychology and Neuroscience, Department of Neuropsychology and Psychopharmacology, Maastricht University, Maastricht, Netherlands.

[3]Department of Education, Psychology, Communication, University of Bari Aldo Moro, Bari, Italy.

[4]Centre for Eudaimonia and Human Flourishing, University of Oxford, Oxford, United Kingdom.

[5]Department of Psychiatry, University of Oxford, Oxford, United Kingdom

BACKGROUND
Neuroimaging studies investigating the mechanisms of recognition memory have largely neglected temporal brain dynamics and the impact of stimulus complexity on neural activity. The aim of this study was to describe the spatiotemporal correlates of auditory recognition memory by adopting a novel strategy for varying the complexity of musical sequences.

AIMS
With this study, we sought to (1) replicate previous findings on the neural mechanisms underlying auditory recognition memory for temporal sequences, and (2) investigate whether stimulus complexity modulates these mechanisms.

METHODS
We selected musical sequences that conformed to tonality, the predominant musical system in Western music, and altered the distance between pitches to obtain matched atonal sequences. Using the high temporal resolution of magnetoencephalography (MEG), we recorded the neural activity of 71 participants in an old/new auditory recognition task. Participants listened to four repetitions of two musical pieces and later had to recognize short sequences extracted from them.

RESULTS
We found qualitative changes in neural activity dependent on stimulus complexity: the recognition of tonal sequences was supported by frontal and mesotemporal brain areas linked to memory processing, such as the cingulate and paracingulate gyri, parahippocampal cortex and hippocampus, while recognition of atonal music mainly activated an auditory processing network, including the temporal gyrus, Heschl's gyrus, and planum temporale. In addition, we observed behavioural differences: participants were more accurate and faster in responding to memorized tonal sequences than to memorized atonal sequences.

DISCUSSION
Our results are consistent with previous studies: the brain areas activated during the recognition of tonal sequences confirmed the involvement of a widespread brain network including both auditory and memory processing regions (Alluri et al., 2012; Bonetti et al., 2021; Burunat et al., 2014). In addition, we observed significant differences in the recognition of two categories of musical sequences. These results can be interpreted in light of three theoretical frameworks: predictive coding of music (PCM), harmonicity, and global neuronal workspace (GNW). According to PCM theory, the brain's predictive model is updated while listening to music in order to decrease precision-weighted prediction errors (Vuust et al., 2022). As the predictive value of atonal music is weaker than tonal music, its processing and enjoyment are undermined (Daynes, 2011; Krumhansl & Cuddy, 2010; Mencke et al., 2018; Nieminen et al., 2012). An alternative explanation for our results focuses on the harmonicity of auditory sequences. Tonal music has been closely linked to the harmonic series, a natural sequence of sound frequencies that is inherently processed by the tonotopic organization of the human auditory cortex (Lewicki, 2002; Norman-Haignere et al., 2019). Conversely, atonal music is built upon patterns that are not coherent with harmonicity, making it more complex to process (Mencke et al., 2021; Vuvan et al., 2014). Finally, our results are also consistent with the GNW hypothesis, which proposes that stimuli become conscious when they ignite late, high-order regions in response to the activation of sensory cortices (Dehaene et al., 1998; Mashour et al., 2020). Here, we confirm that stimulus complexity modulates the transition from primary sensory areas to the GNW.

Our findings provide further evidence for the neural correlates of recognition of auditory sequences and support the idea that stimulus complexity qualitatively alters the brain mechanisms of recognition memory.

REFERENCES
Alluri, V., Toiviainen, P., Jaaskelainen, I. P., Glerean, E., Sams, M., & Brattico, E. (2012). Large-scale brain networks emerge from dynamic processing of musical timbre, key and rhythm. *NeuroImage*, 59(4), 3677-3689.

Bonetti, L., Brattico, E., Carlomagno, F., Donati, G., Cabral, J., Haumann, N. T., … Kringelbach, M. L. (2021). Rapid encoding of musical tones discovered in whole-brain connectivity. *NeuroImage*, 245, 118735.

Burunat, I., Alluri, V., Toiviainen, P., Numminen, J., & Brattico, E. (2014). Dynamics of brain activity underlying working memory for music in a naturalistic condition. *Cortex*, 57, 254-269. https://doi.org/10.1016/j.cortex.2014.04.012

Daynes, H. (2011). Listeners' perceptual and emotional responses to tonal and atonal music. *Psychology of Music*, 39(4), 468-502.

Dehaene, S., Kerszberg, M., & Changeux, J.-P. (1998). A neuronal model of a global workspace in effortful cognitive tasks. *Proceedings of the national Academy of Sciences,* 95(24), 14529-14534.

Krumhansl, C. L., & Cuddy, L. L. (2010). A theory of tonal hierarchies in music. *Music Perception* (pp. 51-87). Springer.

Lewicki, M. S. (2002). Efficient coding of natural sounds. *Nature Neuroscience*, 5(4), 356-363.

Mashour, G. A., Roelfsema, P., Changeux, J.-P., & Dehaene, S. (2020). Conscious processing and the global neuronal workspace hypothesis. *Neuron*, 105(5), 776-798.

Mencke, I., Omigie, D., Wald-Fuhrmann, M., & Brattico, E. (2018). Atonal music: Can uncertainty lead to pleasure? *Frontiers in Neuroscience*, 12, 979.

Mencke, I., Quiroga-Martinez, D. R., Omigie, D., Michalareas, G., Schwarzacher, F., Haumann, N. T., … Brattico, E. (2021). Prediction under uncertainty: Dissociating sensory from cognitive expectations in highly uncertain musical contexts. *Brain Research*, 1773, 147664.

Nieminen, S., Istók, E., Brattico, E., & Tervaniemi, M. (2012). The development of the aesthetic experience of music: preference, emotions, and beauty. *Musicae Scientiae*, 16(3), 372-391.

Norman-Haignere, S. V., Kanwisher, N., McDermott, J. H., & Conway, B. R. (2019). Divergence in the functional organization of human and macaque auditory cortex revealed by fMRI responses to harmonic tones. *Nature Neuroscience,* 22(7), 1057-1060. https://doi.org/10.1038/s41593-019-0410-7

Vuust, P., Heggli, O. A., Friston, K. J., & Kringelbach, M. L. (2022). Music in the brain. *Nature Reviews: Neuroscience*. https://doi.org/10.1038/s41583-022-00578-5

Vuvan, D. T., Podolak, O. M., & Schmuckler, M. A. (2014). Memory for musical tones: the impact of tonality and the creation of false memories. *Frontiers in Psychology*, 5, 582.

Exploring melodic contour: A clustering approach

Michal N. Goldstein[1,2,3], Pablo Ripollés[1,2,3,4], Morwaread M. Farbood[1,2,3]

[1]Department of Music and Performing Arts Professions, New York University, New York, USA.

[2]Music and Audio Research Laboratory (MARL), New York University, New York, USA.

[3]Center for Language, Music and Emotion (CLaME), New York University, New York, USA.

[4]Department of Psychology, New York University, New York, USA

BACKGROUND

The contour of a melody is the pattern of rising and falling intervals that creates the general shape of the melody (Dowling, 1978; Schmuckler, 1999). Previous studies have focused mainly on characterising contour features, such as mean interval size, lowest and highest notes, and Fourier analysis to quantify the up-down patterns and investigate similarity and common contour shapes (Schmuckler, 1999; Schubert & Stevens, 2006; Salamon & Gómez, 2012). Past work has suggested prevalent general shapes for melodic phrases such as ascending, descending, and arch-shape contours (Huron, 1996).

AIMS

The aim of the current study is to investigate the existence and properties of common general contour shapes, using dimensionality reduction and unsupervised machine-learning clustering methods. This approach was chosen in order to examine the contour data without relying on existing theories that could lead to confirmation biases.

METHODS

The dataset created for the current study includes ~200 single-phrase excerpts of Western melodies from varying genres and sources. All excerpts were normalised across the frequency and time axes. Principal Component Analysis (PCA) was performed in order to examine the significance of recurring patterns amongst the extracted contours from the dataset. Following the dimensionality reduction, k-means clustering, and averaging within each cluster was used to determine the nature of each contour cluster.

RESULTS

The principal component analysis resulted in five principal components that accounted each for more than 5% (and all together for over 60%) of explained variance in the contour data. We thus proceeded with performing a k-mean clustering analysis using five centroids. Visualisation of the averaged contour within each cluster suggests a replication of previous findings regarding the prevalence of ascending, descending, and arch-shaped contours.

The results also revealed differences in mean pitch height between contour patterns as well as a binary subphrase structure.

DISCUSSION

Statistical and data-science methods provide an opportunity to reliably investigate hypotheses that are based in music theory and perception. The current study represents a preliminary investigation into musical contour that is applicable to music theory and cognition as well as music information retrieval.

REFERENCES

Dowling, W. J. (1978). Scale and contour: Two components of a theory of memory for melodies. *Psychological Review, 85*(4), 341.

Huron, D. (1996). The melodic arch in Western folksongs. *Computing in Musicology, 10*, 3-23.

Salamon, J., & Gómez, E. (2012). Melody extraction from polyphonic music signals using pitch contour characteristics. *IEEE transactions on audio, speech, and language processing, 20*(6), 1759-1770.

Schubert, E., & Stevens, C. (2006). The effect of implied harmony, contour and musical expertise on judgments of similarity of familiar melodies. *Journal of New Music Research, 35*(2), 161-174.

Schmuckler, M. A. (1999). Testing models of melodic contour similarity. *Music Perception, 16*(3), 295-326.

Investigating the role of social cohesion in the creative process of rhythmical group improvisation

Adrian Kempf, Andrea Schiavio

University of Graz, Graz, Austria

BACKGROUND

Recent research has demonstrated the importance of social dynamics for group creativity (Oztop et al., 2018; Hennessey et al., 2020) and for music-making (Savage et al., 2021). Within this research area, it remains an open question whether social dynamics affect performance in musical group improvisation, a creative task par excellence.

AIMS

We aim to address this question by examining if social cohesion with a virtual improvisation partner influences creativity in a rhythmic improvisation task.

METHOD

18 musical novices (M = 36.83 years, SD = 14.86) were recruited for an online experiment with 3 counterbalanced within-subject conditions. Every condition started with a block of up to two priming tasks and was followed by an improvisation phase. In condition (1) participants were invited to watch a stick-figure drummer (avatar) hitting a cymbal in synchrony with the beat of a drum track. Condition (2) started with the same prime but was followed by a task where participants were invited to move their mouse in synchrony with a moving dot to a metronome click track. Condition (3) was similar to condition (1) but participants moved their mouse in synchrony with the avatar. The aim of this latter task was to facilitate social cohesion to the avatar (Rennung & Göritz, 2016; Stupacher et al., 2020). In the subsequent improvisation phase, participants performed three short improvisations. While watching the avatar move to a backing track, they improvised by triggering two conga samples via their own keyboard. Before and after the improvisation phase, participants responded to a questionnaire which included an assessment of their social cohesion with the avatar ("IOS" scale; see Aron et al., 1992). All improvisation trials were rated for creativity by 9 expert musicians (M = 32.11 years, SD = 9.32). We used linear mixed models to test the difference in social cohesion between conditions and the effect of social cohesion on creativity.

RESULTS

A significant increase (b = 2.01, 95% CI[1.67, 2.36]) of closeness before the improvisation phase was only found for condition (3) compared to condition (1). No significant difference in creativity was found between conditions. However, we found a significant negative correlation (C(1): b = -0.23, 95% CI[-0.40, -0.05]; C(3): b = -0.20, 95% CI[-0.37, -0.02]) between the mean measured social cohesion and creativity for condition (1) and (3).

DISCUSSION

Our findings suggest that during musical improvisation, social cohesion with an avatar inhibits creativity in musical novices. However, this negative correlation was not found in condition (2), and no effect of increased social cohesion (as measured by the IOS) on creativity emerged when comparing condition (3) to (1). The difference between condition (2) and the others might be associated with the role of self-focused actions, which participants did not carry out in conditions (1) and (3). Future work might extend these results to include comparisons between expert and novice improvisers in social contexts, both in performance and educational settings.

REFERENCES

Aron, A., Aron, E. N., & Smollan, D. (1992). inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology*, *63*(4), 596–612.

Hennessey, B. A., Altringer, B., & Moran, S. (2020). Social psychology of creativity. In E. G. Carayannis (Ed.), *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship* (pp. 2189–2195). Springer International Publishing. https://doi.org/10.1007/978-3-319-15347-6

Oztop, P., Katsikopoulos, K., & Gummerum, M. (2018). Creativity through connectedness: The role of closeness and perspective taking in group creativity. *Creativity Research Journal*, *30*(3), 266–275.

Rennung, M., & Göritz, A. S. (2016). Prosocial consequences of interpersonal synchrony: a meta-analysis. *Zeitschrift Für Psychologie*, *224*(3), 168–189. https://doi.org/10.1027/2151-2604/a000252

Savage, P. E., Loui, P., Tarr, B., Schachner, A., Glowacki, L., Mithen, S., & Fitch, W. T. (2021). Music as a coevolved system for social bonding. *Behavioral and Brain Sciences*, *44*, e59.

Stupacher, J., Witek, M. A. G., Vuoskoski, J. K., & Vuust, P. (2020). Cultural familiarity and individual musical taste differently affect social bonding when moving to music. *Scientific Reports*, *10*(1), 10015.

Understanding music for sleep: Results from an online listening study

Rory J.D. Kirk

University of Sheffield, Sheffield, United Kingdom

BACKGROUND

Why does music help people sleep? Several surveys on the self-help methods people use to help with sleep have found music to be one of the most popular choices (e.g., Furihata et al., 2011; Huang et al., 2018) and there has been considerable research interest in the use of music as a non-pharmacological sleep aid (Jespersen et al., 2015). However, conceptualizations of sleep music are typically based on acoustical properties and less is known about the subjective values of listeners. How is 'sleep music' subjectively perceived by listeners, and what qualities and affordances are important for sleep induction?

AIMS

We conducted an exploratory listening study to gather listeners' perceptions of music categorized for the purpose of sleep. We compared sleep music with music considered relaxing and energizing to evaluate the different qualities and affordances related to these purposes.

METHOD

An online survey presented participants (N=109) with 14 random musical excerpts (one minute in length) from a set of 56. Stimuli included samples selected from a previous analysis of Spotify playlists corresponding to sleep, relaxing, and energizing music, music from previous sleep studies, and music created specifically for this study. Participants rated each excerpt along 13 bipolar scales relating to themes including valence, arousal, comfort, absorption, and potential for sleep induction. To embellish the data, acoustical properties of the stimuli were extracted using the MIR toolbox for MATLAB (Lartillot et al., 2008). Analysis included statistical comparisons between the three categories (sleep, relaxing, energizing), principal component analysis (PCA) of the ratings, and regression to determine which factors contributed to sleep induction ratings.

RESULTS

Overall, sleep music was associated with positive valence and low arousal, conforming with previous theoretical suggestions (Jespersen & Vuust, 2012). Compared to relaxing music, sleep music was significantly lower in ratings corresponding to arousal (more calming, sleepy, and sedating) and more comforting, but not significantly different in terms of valence ratings (positivity, pleasantness), absorption, or engagement. Ratings for sleep induction were significantly predicted by variables corresponding to arousal, along with liking, comfort, 'freeing the mind', *un*familiarity, and acoustic properties of brightness and event density.

DISCUSSION

Our findings contribute to our understanding of music for the purpose of sleep and provide important considerations for the selection of music in future studies. The significance of comfort is particularly intriguing; promoting feelings of comfort and safety could be important avenues by which music supports wellbeing, perhaps by way of acting as a social surrogate (Schäfer et al., 2020), and this could be an important mechanism for sleep. Intuitively, familiarity might be expected to be an important factor related to comfort, yet our results suggest that music was more sleep inducing if it was *less* familiar, offering another point for consideration. Finally, the significance of brightness in predicting sleep induction ratings emphasizes a feature hitherto largely overlooked in the sleep music literature.

REFERENCES

Furihata, R., Uchiyama, M., Takahashi, S., Konno, C., Suzuki, M., Osaki, K., Kaneita, Y., & Ohida, T. (2011). Self-help behaviors for sleep and depression: A Japanese nationwide general population survey. *Journal of Affective Disorders*, *130*(1), 75–82. https://doi.org/10.1016/j.jad.2010.09.019

Huang, C. Y., Chang, E. T., & Lai, H. L. (2018). Use of integrative medicine approaches for treating adults with sleep disturbances. *Applied Nursing Research*, *43*, 49–55. https://doi.org/10.1016/j.apnr.2018.06.016

Jespersen, K. V., Koenig, J., Jennum, P., & Vuust, P. (2015). Music for insomnia in adults. *Cochrane Database of Systematic Reviews*, *8*. https://doi.org/10.1002/14651858.CD010459.pub2

Jespersen, K. V., & Vuust, P. (2012). The effect of relaxation music listening on sleep quality in traumatized refugees: A pilot study. *Journal of Music Therapy*, *49*(2), 205–229. https://doi.org/10.1093/jmt/49.2.205

Lartillot, O., Toiviainen, P., & Eerola, T. (2008). A Matlab Toolbox for music information retrieval. In *Data Analysis, Machine Learning and Applications* (pp. 261–268). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-78246-9_31

Schäfer, K., Saarikallio, S., & Eerola, T. (2020). Music may reduce loneliness and act as social surrogate for a friend: evidence from an experimental listening study. *Music & Science*, *3*.

Event-Related Frequency Adjustment (ERFA). A paradigm and a measure for investigating neural entrainment

Mattia Rosso[1], Bart Moens[1], Marc Leman[1], Lousin Moumdjian[1,2]
[1]IPEM, Ghent University, Ghent, Belgium.
[2]Hasselt University, Hasselt, Belgium

BACKGROUND

Neural entrainment has become a phenomenon of exceptional interest to neuroscience, given its involvement in rhythm perception, production, and overt synchronised behaviour. The very definition of 'entrainment' implies some assumptions about the underlying physiology, the most important being that endogenous oscillatory brain activity undergoes phase- and frequency-locking to rhythmic environmental stimuli (Lakatos et al., 2019). Last year, we proposed the Stability Index (SI) as a measure to quantify neural entrainment from electroencephalography (EEG) in healthy participants engaged in finger-tapping to a steady auditory metronome (Rosso et al., 2021). We argued that, in contrast to approaches previously used to quantify neural entrainment (e.g., see Novembre and Iannetti, 2018; Rajandran and Schupp, 2019), our measure explicitly accounts for the dynamic phase-adjustment of neural oscillations underlying the process. The putative entrained component would adaptively speed up and slow down, fluctuating around the centre stimulation frequency to reach stable synchronisation over time.

AIMS

Moving from a fundamental definition of neural entrainment, it is important to look for the operational definition which better describes it, and ultimately allow to quantify it with experimental work. Motivated by the need for 'zooming in' into its dynamics, we developed the 'Event-Related Frequency Adjustment' (ERFA) paradigm to elicit adaptive change in the phase of entrained neural activity by systematically manipulating rhythmic stimuli. Our aim is to present a sensitive approach capable of measuring neural entrainment according to its definition, along with some key insights from our preliminary results.

METHOD

20 healthy participants took part in the study. They were instructed to tap their finger in sync with an isochronous auditory metronome, which was unpredictably perturbated by phase-shifts and tempo-changes across different experimental conditions, in both positive and negative directions. EEG was recorded during the task. Via the procedure described in Rosso et al. (2021), we extracted from the EEG signal an auditory and a sensorimotor component maximally attuned to the metronome's frequency, and computed ERFAs as the neural instantaneous frequency response to the perturbations.

RESULTS

Behavioural dynamics of error corrections consistently confirm the findings of previous works on finger tapping (Repp and Su, 2013), while displaying clusters of different individual strategies.
At the neural level, ERFAs track the stimulus dynamics according to the perturbation type and direction, preferentially for the sensorimotor component. Although the analyses are still preliminary, clear and consistent patterns emerge for the instantaneous frequency response of the entrained components, strongly suggesting that our method is sensitive to the phase alignment process defining neural entrainment.

DISCUSSION

ERFAs show that EEG components attuned to the stimulation frequency are responsive to perturbations, exhibiting the predicted changes in instantaneous frequency to track the stimulus dynamics. We therefore propose that our method can capture the neural entrainment underlying sensorimotor synchronization.
Our findings fit well with contemporary neurophysiological models of beat perception and overt behavioural entrainment (Cannon and Patel, 2021), postulating that a neural representation of movement and stimulus phase is constantly updated by cyclic dynamics in the supplementary motor area, allowing predictive synchronisation behaviour and beat perception.

REFERENCES

Cannon, J. J., & Patel, A. D. (2021). How beat perception co-opts motor neurophysiology. *Trends in Cognitive Sciences*, 25(2), 137-150.

Lakatos, P., Gross, J., & Thut, G. (2019). A new unifying account of the roles of neuronal entrainment. *Current Biology*, 29(18), R890-R905.

Novembre, G., & Iannetti, G. D. (2018). Tagging the musical beat: Neural entrainment or event-related potentials?. *Proceedings of the National Academy of Sciences,* 115(47), E11002-E11003.

Rajendran, V. G., & Schnupp, J. W. (2019). Frequency tagging cannot measure neural tracking of beat or meter. *Proceedings of the National Academy of Sciences*, 116(8), 2779-2780.

Repp, B. H., & Su, Y. H. (2013). Sensorimotor synchronization: a review of recent research (2006–2012). *Psychonomic Bulletin & Review*, 20(3), 403-452.

Rosso, M., Leman, M., & Moumdjian, L. (2021). Neural entrainment meets behavior: the stability index as a neural outcome measure of auditory-motor coupling. *Frontiers in Human Neuroscience*, 15.

Does empathy mediate the social bonding effects of interpersonal synchronisation during an online tapping task?

Persefoni Tzanaki

University of Sheffield, Sheffield, United Kingdom

BACKGROUND
Music psychology research has revealed that moving in synchrony with others fosters feelings of closeness, similarity and empathy (Stupacher, Maes et al., 2017; Rabinowitch & Knafo-Noam, 2015; Rabinowich et al., 2013). Researchers have recently discovered that these social bonding effects can be mediated by trait empathy (Stupacher et al., 2021), i.e., one might experience stronger or weaker effects depending on their empathy level. However, this mediating role of empathy has only been explored in perception tasks (Stupacher et al., 2021), and it remains unclear whether such an effect exists when individuals actively engage in musical interactions with other people.

AIMS
The present study aimed to explore how trait empathy influences the strength of feelings of closeness, similarity and situational empathy (social bonding effects) that stem from interpersonal synchronisation when individuals engage in online tapping interactions with ostensible partners.

METHODS
Eighty-eight individuals with little or no previous musical training participated in an online tapping task. Prior to the task, participants' trait empathy was measured using the Interpersonal Reactivity Index (Davis, 1980). Participants were then asked to tap along with the beat of some music while listening to some tapping sequences that, they were led to believe, belonged to previous participants. During tapping, participants were asked to imagine that the other person was present, tapping and interacting with them. In fact, the tapping sequences were manipulated based on four conditions: 1) synchronous, in-phase tapping; 2) synchronous, anti-phase tapping; 3) asynchronous, in-phase tapping; and 4) asynchronous, anti-phase tapping. The asynchronous conditions were created by adding or subtracting 15% of the inter-onset interval (IOI) to each tap of a synchronised in-phase or anti-phase tapping sequence. The result of this manipulation gave the impression that the tapping was produced by an individual who was unsure or unable to perform in synchrony with the music. The musical stimuli were presented in slow (83bpm), moderate (100bpm) and fast (125bpm) tempi. Participants completed twelve trials, all of which were followed by participants rating their feelings of closeness, similarity, and situational empathy toward their interacting partners.

RESULTS
As data analysis is still in progress, we anticipate finding that individuals with higher empathy experienced stronger social bonding effects toward synchronous partners, while those with lower empathy experienced a stronger disconnection from asynchronous partners. We further anticipate that the anti-phase conditions triggered stronger effects, with condition 2 leading to stronger social bonding and condition 4 leading to stronger disconnection, regardless of participants' empathy level.

DISCUSSION
This is the first study to explore the role of empathy in mediating the social bonding effects of synchronization in musical interactions that involve active motor engagement. Research on this topic offers a deeper understanding of the multifaceted relationship between empathising and synchronising with others, highlighting an emergent interplay between personal characteristics and synchronisation proximity in the general public. The implications for music and social psychology could be the implementation of this interplay to design more contextually sensitive musical interventions aiming to foster social bonding and increase empathy in society.

REFERENCES
Rabinowitch, T. C., Cross, I., & Burnard, P. (2013). Long-term musical group interaction has a positive influence on empathy in children. *Psychology of Music, 41*(4), 484-498.

Rabinowitch, T. C., & Knafo-Noam, A. (2015). Synchronous rhythmic interaction enhances children's perceived similarity and closeness towards each other. *PLoS ONE, 10*(4), 1-10.

Stupacher, J., Maes, P. J., Witte, M., & Wood, G. (2017). Music strengthens prosocial effects of interpersonal synchronization–If you move in time with the beat. *Journal of Experimental Social Psychology*, 72, 39-44.

Stupacher, J., Mikkelsen, J., & Vuust, P. (2021). Higher empathy is associated with stronger social bonding when moving together with music. *Psychology of Music,* 1-16.

The impact of neurocognitive disorders on sensorimotor synchronization with simple and complex rhythmic sequences

Andres von Schnehen[1], Lise Hobeika[2,1], Dominique Huvent-Grelle[3], François Puisieux[3], Séverine Samson[1,2,4]

[1]Université de Lille, ULR 4072 – PSITEC – Psychologie: Interactions, Temps, Emotions, Cognition, Lille, France.

[2]Sorbonne Université, Institut du Cerveau - Paris Brain Institute - ICM, Inserm, CNRS, APHP, Hospital de la Pitié Salpetrière, Paris, France.

[3]Hôpital Gériatrique les Bateliers, Pôle de Gérontologie, CHU Lille, Lille, France.

[4]Epilepsy Unit, AP-HP, GHU Pitié-Salpêtrière-Charles Foix, Paris, France

BACKGROUND

Music-based interventions are increasingly suggested in the care of people suffering from neurocognitive disorders (NCDs; Kales et al., 2015), and are recommended more and more even for healthy older adults (Jünemann et al., 2022; Worschech et al., 2021). While promising outcomes have been observed in terms of behaviour, mood, and even cognition (Särkämö et al., 2014), little is known about how and why these interventions exert their positive effects. We propose that active interventions favouring sensorimotor synchronization (SMS) might be particularly effective (Hobeika & Samson, 2020). To tailor interventions to those who will maximally benefit from them, it is crucial to understand how SMS abilities are affected by age and by NCDs.

AIMS

Using an SMS paradigm with musical and metronomic stimuli containing sudden tempo changes, we test how older adults with and without NCDs perform in terms of tapping consistency and accuracy. Moreover, we analyse spontaneous nonverbal behaviour and facial expressions to obtain a comprehensive picture of the ways in which this population responds to musical stimulation.

METHODS

We recruit around 60 older adults from a geriatric day hospital in Lille, France, that accommodates people with diverse neurocognitive profiles, including people with major, mild, and absence of NCDs. Participants engage in a synchronization paradigm in which they tap along with sequences that are either a simple metronome or a well-known French song (chosen by the researcher), in both cases 75 seconds long and either with a stable, unchanging tempo or containing periodic tempo changes. This allows us to test the effect of cognitive impairment, auditory context (music vs. metronome) and tempo stability (stable vs. changing tempo) on SMS performance as well as socio-emotional and motor engagement, coded by external observers who were blind to the respective conditions.

RESULTS

We expect an effect of tempo stability on SMS performance, as well as a tempo stability*group interaction, in the sense that consistency and accuracy will be lower when tapping to sequences containing tempo changes, an effect assumed to be amplified in patients with NCDs. In terms of socio-emotional engagement, we expect less movement and fewer positive facial expressions in people with compared to without NCDs, similar to Hobeika et al. (2021). Finally, we expect a higher proportion of gaze directed at the participant's own hand in the changing-tempo condition, reflecting task difficulty, an effect thought to be amplified in people with NCDs.

DISCUSSION

We discuss the expected results in terms of brain networks involved in SMS. In particular, the performance in the stable-tempo condition should be linked to activity in areas that are relatively preserved in NCDs, such as the cerebellum and supplementary motor area (Lewis & Miall, 2003; Liang & Carlson, 2020). We discuss adaptive tapping to sequences with shifting tempos as a more cognitively controlled type of SMS, relying on structures that are relatively more impaired in NCDs, particularly in the prefrontal and parietal cortices (Koch et al., 2009; Rémy et al., 2015). Moreover, we discuss socio-emotional and motor engagement and its relevance to the development of effective music-based interventions.

REFERENCES

Ghilain, M., Hobeika, L., Lesaffre, M., Schiaratura, L., Singh, A., Six, J., … Samson, S. (2020). Does a live performance impact synchronization to musical rhythm in cognitively impaired elderly? *Journal of Alzheimer's Disease*, 78, 939–949. https://doi.org/10.3233/JAD-200521

Hobeika, L., Ghilain, M., Schiaratura, L., Lesaffre, M., Huvent-Grelle, D., Puisieux, F., & Samson, S. (2021). Socio-emotional and motor engagement during musical activities in older adults with major neurocognitive impairment. *Scientific Reports*, 11(1), 1–9. https://doi.org/10.1038/s41598-021-94686-4

Hobeika, L., & Samson, S. (2020). Why do music-based interventions benefit persons with neurodegenerative disease? In L. L. Cuddy, S. Belleville, & A. Moussard (Eds.), *Music and the Aging Brain* (pp. 333–349). *Academic Press*. https://doi.org/10.1016/B978-0-12-817422-7.00013-4

Jünemann, K., Marie, D., Worschech, F., Scholz, D. S., Grouiller, F., Kliegel, … Sinke, C. (2022). Six months of piano training in healthy elderly stabilizes white matter microstructure in the fornix, compared to an active control group. *Frontiers in Aging Neuroscience*, 14, 1–13.

Kales, H. C., Gitlin, L. N., & Lyketsos, C. G. (2015). Assessment and management of behavioral and psychological symptoms of dementia. *BMJ*, 350, h369. https://doi.org/10.1136/bmj.h369

Koch, G., Oliveri, M., & Caltagirone, C. (2009). Neural networks engaged in milliseconds and seconds time processing: Evidence from transcranial magnetic stimulation and patients with cortical or subcortical dysfunction. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1525), 1907–1918.

Lewis, P. A., & Miall, R. C. (2003). Distinct systems for automatic and cognitively controlled time measurement: Evidence from neuroimaging. *Current Opinion in Neurobiology*, 13(2), 250–255.

Liang, K. J., & Carlson, E. S. (2020). Resistance, vulnerability and resilience: A review of the cognitive cerebellum in aging and neurodegenerative diseases. *Neurobiology of Learning and Memory*, 170, 106981.

Rémy, F., Vayssière, N., Saint-Aubert, L., Barbeau, E., & Pariente, J. (2015). White matter disruption at the prodromal stage of Alzheimer's disease: Relationships with hippocampal atrophy and episodic memory performance. *NeuroImage: Clinical*, 7, 482–492. https://doi.org/10.1016/j.nicl.2015.01.014

Särkämö, T., Tervaniemi, M., Laitinen, S., Numminen, A., Kurki, M., Johnson, J. K., & Rantanen, P. (2014). Cognitive, emotional, and social benefits of regular musical activities in early dementia: Randomized controlled study. *Gerontologist*, 54(4), 634–650. https://doi.org/10.1093/geront/gnt100

Worschech, F., Marie, D., Jünemann, K., Sinke, C., Krüger, T. H. C., Großbach, M., Scholz … Altenmüller, E. (2021). Improved speech in noise perception in the elderly after 6 months of musical instruction. *Frontiers in Neuroscience*, 15, 696240.

POSTER PRESENTATIONS

COPD gymnastic: Combination of ai chi program hydrotherapy and music therapy in patients with chronic obstructive pulmonary disease

Bayu Aji Prasetya, Rizka Lailatul Rohmah
Universitas Sebelas Maret, Surakarta, Indonesia

Background
Currently, 64 million people suffer from COPD, and 3 million people die from it. COPD will be the third-leading cause of death in the world by 2030 (WHO, 2018). Ai Chi programs, hydrotherapy, and music therapy can be used in pulmonary rehabilitation programmes (Brody & Geigle, 2009). In a pulmonary rehabilitation programme that aims to improve respiratory function in COPD patients, interventions can be given in the form of physical exercise, one of which is COPD gymnastics. COPD patients experience basic respiratory incompetence in the form of shortness of breath, chronic cough, chronic sputum production, and activity limitations. Physical exercise for people with COPD is primarily aimed at reducing symptoms, improving quality of life, and increasing daily activities (Andri, 2018).

Aims
In the formulation of the American Music Therapy Association (1997), music therapy is a profession in the health sector that uses music and music-related activities to overcome various problems in the physical, psychological, cognitive, and social needs of individuals with physical disabilities (Stan, 2013).

Methods
The method used is a literature review of articles obtained from electronic media such as Google Scholar, Science Direct, NCBI, and PubMed with the keywords COPD, Tai Chi, and music therapy.

Results
COPD Gymnastics combines the Ai Chi movement with music therapy. This gymnastics is performed in the water at about shoulder height. It is carried out by a combination of diaphragmatic breathing and slow movements to the accompaniment of instrumental music (Nafilasari, 2013). The advantages of COPD gymnastics will increase COPD patients' focus on breathing. Music therapy can also improve breath rate control, reduce hyperinflation, reduce dyspnea, and improve the patient's quality of life. Pulmonary rehabilitation is a therapy that is considered effective in improving the quality of life, physical health, and emotional health of COPD patients (Aryadi, 2018).

Discussion
The prospect of developing COPD Gymnastic can be assessed in a SWOT (Strength, Weakness, Opportunity, Threat) analysis:
- Strength: Safe for the elderly and people suffering from neuromusculoskeletal disorders because they use water media, so they have a lower risk of falling.
- Weakness: Requires a medium in the form of water, so not everyone can do it at home and COPD Gymnastic is not yet known to the general public.
- Opportunity: Ai Chi and music therapy have an effect that can improve the quality of life of COPD sufferers.
- Threat: Patients who do not want to do therapy.
- Strength Opportunity Strategy: This is one of the government's new programs in the management of COPD that is safe to apply in almost all conditions.
- Strength Threat Strategy: Socialization about the importance of COPD Gymnastic as a pulmonary rehabilitation program.
- Weakness Threat Strategy: Become a government program in COPD management. Further testing on the benefits of the program will be carried out and the results will be published.
- Weakness Opportunity Strategy: Provision of facilities and infrastructure to fulfil government programs.

References
Aryadi, I. P. H. (2018). Yoga pranayama dan terapi musik: Sebuah kombinasi terapi rehabilitatif holistik pada penderita penyakit paru obstruktif kronis (PPOK). Universitas Udayana, 1–25.
Brody, L.T., & Geigle, P. R. (2009). *Aquatic exercise for rehabilitation and training*. Champaign, USA: Human Kinetics.
Nugroho, I. A., Sukartini, T., & Sriyono, S. (2018). Low impact aerobic exercise dapat menurunkan keluhan gejala pasien penyakit paru obstruktif kronik. *Proceeding of the 7th University Research Colloquium (URECOL)*. Accessed from http://repository.urecol.org/index.php/proceeding/article/view/180

Nafilasari, M. Y. (2013). *Perbedaan tekanan darah pada lansia hipertensi sebelum dan sesudah diberikan terapi musik instrumental di panti werda pengayoman pelkris kota semarang.* Thesis, STIKES Telogorejo. Accessed from http://ejournal.stikestelogorejo.ac.id/index.php/ilmukeperawatan/article/view/131

Stan, A. E. (2013). *Psychological effects of aquatic activity in hydrotherapy programs.* Marathon, Department of Physical Education and Sport, Academy of Economic Studies, Bucharest, Romania, vol. 5(2).

World Health Organization. (2018). *Chronic obstructive pulmonary disease (COPD).* Accessed from https://www.who.int/respiratory/copd/en/

Influence of environmental sounds and electromagnetic field on the perception of noise

Asli Bala Askan

Istanbul Technical University, Istanbul, Turkey

BACKGROUND

This paper analyses the relationship between a soundscape and the noise perception of individuals through an intersection of sound, musical creativity, and electronics. The topic will be approached through an alternative layer of soundscape: electromagnetic field sounds (EmF). As an alternative and mostly ignored part of the soundscape, EmF signifies the importance of simple choices in our daily lives in a semi-audible environment. Devices we carry, cell towers we use, vehicles we use for transportation, etcetera, all influence the EmF and its contributions to the "displeasing sounds." This influences both individual and social perceptions of environmental noise.

AIMS

The difference between EmF recordings and the audible sounds of their sources (e.g., antennas, power centers), provides essential information about the concept of noise as an 'unwanted sound' instead of an aural coincidence. This perception of noise influences the noise's place in music, both electroacoustic and acoustic-wise. The result of the environment is also visible in some styles of electroacoustic music. The relationship between noise and electroacoustic music is already an ongoing discussion. With its constantly shifting techniques and meanings in a continually developing musical meta-genre, many noise examples from electronic music show a wide range of influences from environmental sounds or the sound sources that are generally labelled as 'unpleasant.'

METHOD

Sound recordings from the Camlica TV Tower's EmF will be analysed under the acoustic ecology, aural environment, and soundscape scopes. While all of these terms refer to a similar concept, the placement of EmF and the audible sounds of EmF sources fall under different classifications. Field recordings from the construction phase of the tower and interviews with the locals will generate the discussion base for noise perception. Electromagnetic Field recordings of the same structures both during and after the construction will cover the practical parts of the research. In various spectral analyses, differences and similarities between the two fields from the same source will lead this research into a more theoretical discussion. The chosen place is the small-scale de-forestation of one of the small parks of a crowded urban area, the public reaction made against it, and the acoustic changes in the field, both at an audible level and at the EmF level.

RESULTS

The effects of environmental sounds (at various levels) on our noise perception and how they influence the musical outcomes of "noise" will be the primary focus of this research. The multi-layered soundscape and how audible and non-audible sounds affect the natural habitat and its inhabitants (humans and fauna), resulting in the perception of a "silent, peaceful place."

DISCUSSION

The selected artworks will examine the relationship between musical perception, environment, and noise through a contemporary music lens. Also, in other parts of this research, environmental noise and its impact on depopulation and the repopulation of a field will be shown. How the de-activation and activation of the antennas shift the population in-between open areas in a public park will be displayed and discussed.

Fluency through synchrony: Social bonding effects of drumming mediated by cognitive load

Joshua S. Bamford[1], Bronwyn Tarr[1], Lynden Miles[2], Emma Cohen[1]
[1]University of Oxford, Oxford, United Kingdom.
[2]University of Western Australia, Perth, Australia

BACKGROUND

Building upon Dunbar (2012), Savage et al. (2021) argue that the human capacity for musicality evolved because musical behaviour enables social bonding in increasingly large group sizes. It appears as though the synchronisation achieved during musical activity may be the active ingredient in this effect (Bamford, 2016; Tarr et al., 2016). Wheatley and Sievers (2016) suggest that synchronisation may enhance processing fluency, inducing a state of decreased cognitive load, during social interaction. Processing fluency itself is often perceived as pleasurable and rewarding across many domains (Reber et al., 2004). Previous work has found synchrony to be easier to process than non-synchrony, however it remains to be tested whether this mediates bonding effects.

AIMS

To further develop and test an account of social bonding arising from processing fluency for synchronised movement.

METHOD

82 undergraduate students completed a series of drumming tasks. There were three levels of synchrony based on tempo ratios, in a within-subjects design: 120-120 BPM, 120-80 BPM, 120-113 BPM. Participants drummed along to a video stimulus and were asked to rate how much they liked the target person in the video, as well as how difficult they found the task. Pupillometry data were also recorded as a secondary measure of processing load.

RESULTS

A mixed effects model found a significant effect of synchrony (120-120 compared with 120-113) on self-reported interpersonal liking, however this effect was entirely mediated by the perceived difficulty of the task. Pupillometry found increased pupil size during the 120-113 condition compared with 120-120, consistent with the subjective ratings of difficulty.

DISCUSSION

These results support the notion that processing fluency contributes to the synchrony bonding effect. It then raises questions about the optimal level of fluency to achieve bonding. Crucially, this provides an explanation for the synchrony-bonding effect that is grounded in general theories of aesthetic perception, and which may complement other theories which pertain specifically to music. It suggests that sensorimotor synchronisation abilities, a crucial component of musicality, may have evolved to leverage basic perceptual principles for social bonding purposes.

REFERENCES

Bamford, J. S., Burger, B., & Toiviainen, P. (2016). Are we dancing to the same beat? empathy and interpersonal synchronisation in the silent disco. In B. Burger, J. S. Bamford, & E. Carlson (Eds.), *The 9th International Conference of Students of Systematic Musicology (SysMus16): Programme, Abstracts & Proceedings*. Jyväskylä, Finland: University of Jyväskylä.

Dunbar, R. I. M. (2012). On the evolutionary function of song and dance. In N. Bannan (Ed.), *Music, Language & Human Evolution* (p. 201). Oxford, UK: Oxford University Press.

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: is beauty in the perceiver's processing experience?. *Personality and Social Psychology Review*, 8(4), 364–382.

Savage, P. E., Loui, P., Tarr, B., Schachner, A., Glowacki, L., Mithen, S., & Fitch, W. T. (2021). Music as a coevolved system for social bonding. *Behavioral and Brain Sciences*, 44, 1–22.

Tarr, B., Launay, J., & Dunbar, R. I. M. (2016). Silent disco: dancing in synchrony leads to elevated pain thresholds and social closeness. *Evolution and Human Behavior,* 37(5), 343–349.

Wheatley, T., & Sievers, B. (2016). Toward a neuroscience of social resonance. In J. D. Greene, I. Morrison, & M. E. P. Seligman (Eds.), *Positive Neuroscience* (pp. 37–54). New York: Oxford University Press.

The application of augmented and virtual reality (AR/VR) in general music classes from the perspective of 21st century skills

Bahareh Behzadaval

Arman Honar Novin Pasargad, Tehran, Islamic Republic of Iran

BACKGROUND

In recent years, the use of ICT has enabled music education to develop novel experiences for better perception of musical concepts. For instance, the paradigm of "embodied music learning" has benefited the potential of digital environments in a social learning circumstance (Nijs et al., 2018). In this way, augmented and virtual reality (AR/VR) are the technologies which facilitate learning in different matters (Pochtoviuk et al., 2020; Checa & Bustillo, 2020). Besides, 21st century skills, such as problem-solving, collaboration, and creative thinking, are aimed at teaching plans in different learning subjects. However, the defined skills are addressed in several research in the field of music education during the last decades, as well (Bressan et al., 2017; Chandler, 2018; Hallam, 2010; Shuler, 2011; Murillo, 2017). General music, as a school subject to be taught in primary and secondary music classrooms (Abril & Gault, 2016), could apply the potential of technologies such as the AR/VR environments for the objectives from the perspective of 21st century skills.

AIMS

In this study, we investigate how AR/VR environments can be applied in general music classes from the perspective of 21st century skills.

METHOD

Here, we use the literature review and the analytical-documentary method. Several terms are searched such as: "21st century skills in music education" and "general music classes", "the AR/VR environments for 21st century skills", "the AR/VR environments in music education and general music classes". The data are extracted from about 80 items, categorised based on the field of studies, and analysed to use the previous works for the future studies.

RESULTS

The study of several articles shows that there is a consensus on the benefits of the AR/VR for 21st century skills. Besides, the AR/VR technologies as the visual environments can depict the complex concepts of different subjects for pupils, such as physics, biology, etc. On the other hand, reports indicate that 21st century skills are an immersive part of the music classes. In the field of music education, terms such as collaboration, problem-solving, and creative thinking are addressed in a large amount of research. Further, the application of ICT as a versatile means is noted to empower 21st century skills, especially collaboration, in the music classes. For instance, the theory of "embodied music" has benefited from digital tools to visualise music among collaborative and creative activities. However, it seems that the application of the AR/VR in music is of interest to researchers, but most of them focus on musical instruments (mostly piano) and musical skills such as notation, which could be better visualised among the learning subjects of music. As a result, AR/VR environments are not covered in general music classes for 21st century skills. According to the results, the AR/VR environments could provide tools to reinforce 21st century classes. These potentials could contribute to the development of multidimensional environments in general 21st century music classes through the application of features such as "visualization," "collaboration", "creativeness", "problem-solving", etc.

DISCUSSION

In conclusion, the AR/VR environments, as unlimited tools to bring an imaginary world (spatial and temporal) to the actual world, are unique platforms for music learning where pupils are engaged with visual and auditory materials in a 21st century class.

REFERENCES

Abril, C. R., & Gault, B. M. (Eds.). (2016). *Teaching general music: Approaches, issues, and viewpoints*. Oxford University Press.

Bressan, F., Vets, T., Lesaffre, M., & Leman, M. (2017). A multimodal interactive installation for collaborative music making: From preservation to enhanced user design. *Proceedings of the 25th Anniversary Conference of the European Society for the Cognitive Sciences of Music*, (pp. 23-26). Ghent.

Chandler, M. D. (2018). Improvisation in elementary general music: A review of the literature. *Applications of Research in Music Education*, 37(1), 42-48.

Checa, D., & Bustillo, A. (2020). A review of immersive virtual reality serious games to enhance learning and training. *Multimedia Tools and Applications*, 5501–5527.

Hallam, S. (2010). 21st century conceptions of musical ability. *Psychology of Music*, 308-330.

Murillo, R. E. (2017). The 21st century elementary music classroom and the digital music curriculum: A synergism of technology and traditional pedagogy. *Texas Music Education Research*, 14-27.

Nijs, L., Bremmer, M., & Dool, J. V. (2018). *Singewing space. An augmented blended-learning approach to music learning.* Research Group Arts Education Amsterdam University of the Arts.

Pochtoviuk, S., Vakaliuk, T., & Pikilnyak, A. (2020). Possibilities of application of augmented reality in different branches of education. Retrieved from SSRN: https://ssrn.com/abstract=3719845

Shuler, S. C. (2011). The three artistic processes: Paths to lifelong 21st-century skills through music. *Music Educators Journal*, 9-13.

Sculpting the chromatic: Triadic pitch-space delineations in Kurtág's Wind Quintet, op. 2

Amelia Brey[1,2]

[1]The Juilliard School, New York, NY, USA.

[2]École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

BACKGROUND

Existing analyses of early works of György Kurtág (such as Halasz, 2002) interpret the composer's early language as essentially twelve-tone, based upon partitioning of the chromatic aggregate. Hohmaier (2002), however, in her articulation of Kurtág's intellectual proximity to the axial harmonic theory articulated by Ernö Lendvai (1971), implies, though does not fully demonstrate, a neo-tonal analytic layer present in these early works. Lendvai's theory, developed through examination of the music of Bartók, consists in the notion that the traditional tonal functions of tonic, subdominant, and dominant may, via relative major/minor substitution, be substituted for those harmonies either three or six semitones distant. Kurtág, like his compatriots György Ligeti and Peter Eötvös, was well familiar with Lendvai's work as a student in Budapest, and Lendvai's thinking offered to all of these composers a markedly Hungarian means of fully chromatic organization.

AIMS

Focusing upon the Wind Quintet, op. 2 (1959), this study attempts to interpret Kurtág's early language in neo-tonal terms. This angle is meant not to supplant the already accepted twelve-tone reading of this work; rather, the two layers coexist and together articulate an underlying formal trajectory. Contrapuntal analysis of non-diatonic music may provide a rigorous baseline for articulating this interrelation.

METHOD

This study synthesizes Lendvai's axis system with the method of post-tonal contrapuntal analysis displayed in Salzer (1962). Kurtág's incorporation of thirds and fifths into the fully chromatic texture of the Wind Quintet is so decisive that it can easily be heard as a signifier of a complete triad. The contrapuntal influence of the triads-so-implied upon the musical fabric of a given movement is charted using Schenker-style graphical analysis.

RESULTS

A graph example of the first movement of the Wind Quintet (Figure 1) appears below. I have used the axis system to interpret the ways these triads are linked. A diagram of axial functional roots (Figure 2) appears below the examples. Intervening pitches are rationalized as elaborations of these triads. The boxed pitches in Figure 1 are not linked to any functional harmony but rather are understood as existing for the sake of completing the aggregate.

Figure 1 | Voice-Leading Reduction of op. 2, mvt. 1
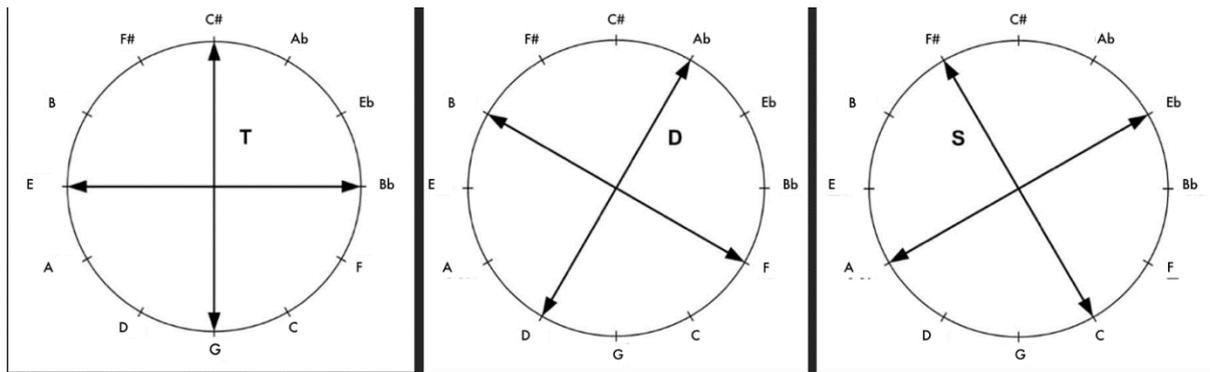
Figure 2 | An Example of The Axis System.

Chordal roots on the tonic, dominant, and subdominant axes are shown. In the graph shown in Figure 1, B-flat and G are taken to be equivalent roots on the tonic axis at the moments marked "T." The stemmed B-natural in the upper voice is understood as a chord member via major-minor mixture.

DISCUSSION

This project identifies an "extended-tonal" perceptual layer that may form a conceptual tension with non-tonal hearing-methods, such as the twelve-tone method, in a modernist work, challenging the false binary of "tonal or not." This is not to argue that *no* music is exclusively tonal or non-tonal, but rather to demonstrate a multilayered analytic approach acknowledging both sides of that dialectic. Indeed, in this conceptual tension stands, beside analytic confusion, much of the power of the composer's art.

REFERENCES

Halasz, P. (2002). On Kurtág's dodecaphony. *Studia Musicologica Academiae Scientarum Hungaricae*, *43*(3/4), 235-252.

Hohmaier, S. (2002). Mutual roots of musical thinking: György Kurtág, Péter Eötvös, and their relation to Ernö Lendvai's theories. *Studia Musicologica Academiae Scientarum Hungaricae*, *43*(3/4), 223-234.

Kurtág, G. (2008). *Wind Quintet, op. 2* [Study score]. Editio Musica. (Original work published 1969).

Lendvai, E. (1971). *Béla Bartók: An analysis of his music*. Kahn & Averill.

Paccione, P. (1988). Chromatic completion: Its significance in tonal and atonal contexts. *College Music Symposium, 28*, 85-93.

Salzer, F. (1962). *Structural hearing: Tonal coherence in music*. Dover.

The affect of the details: The effects of soundtrack's modified intonation on audience's emotional reaction to films

Rúben M. C. Carvalho

Norges Musikkhøgskole, Oslo, Norway

BACKGROUND

After almost a century since the first films with synchronised sound, the technology and techniques behind film scoring have substantially improved. The soundtrack helps to mask external noises, endows a sense of temporality, directs attention, furthers the narrative, creates memory associations, heightens absorption in the film, and, possibly most importantly, induces and expresses emotions and moods (Chion, 2019; Cohen, 1998, 2010; Smith, 1999). However, in what ways can music evoke emotions? Juslin (2013) has outlined a framework that comprises the mechanisms involved in the arousal of emotions, and several researchers have examined how different musical factors contribute to emotional expression (Gabrielsson, 2010; Juslin, 2016; Juslin & Sloboda, 2010; Quinto et al., 2014).

AIMS

One musical element that is less considered in research about music and emotion (and almost completely neglected in film music literature) is intonation, i.e., the adjustment of sounding pitch in music. To some performers, intonation is indispensable when expressing emotion, so much so that singers may sharpen phrase-peak tones by around 50 cents (Sundberg et al., 2013; Vurma & Ross, 2006). This project aims to investigate, through an experiment, if the use of modified intonation can alter how audiences emotionally react to film, either enhancing, weakening, or even altering the emotion.

METHODS

To demonstrate whether modifying a soundtrack's intonation is beneficial for emotional expression, I conducted an experiment where two film clips from two different genres (drama/romance and horror/mystery) were presented to participants five times: the first without any soundtrack, the second with a soundtrack composed for the clip, and the last three times with the same soundtrack but with the intonation modified in different ways. Some modifications were done in order to mimic certain intonational practices, such as just intonation or expressive intonation, whereas others were done with the purpose of increasing tension and being unconventional, such as compressing the melody's range. The 16 adult international participants were asked, in a questionnaire, if they identified any change in their emotional reaction to each clip. The results of the experiment were then supported by a thorough literature review.

RESULTS

The responses to the questionnaire were categorised according to Hevner's adjective circle (1936) to allow for a quantitative analysis by allocating the different responses into set categories. The results show that, despite the modified intonation not changing the overall emotion felt by the participants, some intonational choices had a better outcome on the perceived emotion, such as the use of just intonation in the calmer soundtrack or the intonational compression of the melody in the soundtrack for the horror clip.

DISCUSSION

Due to the small number of participants, it is not possible to derive an absolute theory of modified intonation in film's soundtracks in relation to emotion. However, the analysis of the data reveals some tendencies. For example, there is a preference for just intonation, which correlates to vocal and string ensembles' performance practice, and a rejection of flat intonation, which supports Burns (1999) and Geringer et al. (2001) conclusions, for calmer scenes, while there is no preference for any specific intonational practice for scenes with high emotional activity communicated by the visuals. Interestingly, an uncommon intonation, such as compressing the melody's range, received positive ratings, but its reliability would have to be researched further. The knowledge of these tendencies opens doors for further research into, specially, the relationship between intonation and emotion, the interconnection between musical topics in less researched musical settings, and practical applications.

REFERENCES

Burns, E. M. (1999). Intervals, scales, and tuning. In D. Deutsch (Ed.), *The Psychology of Music* (2nd ed., pp. 215–264). Academic Press.

Chion, M. (2019). *Audio-vision: Sound on screen* (2nd ed.). Columbia University Press.

Cohen, A. J. (1998). The functions of music in multimedia: A cognitive approach. *Fifth Internation Conference on Music Perception and Cognition*, 13–20.

Cohen, A. J. (2010). Music as a source of emotion in film. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, and applications*. Oxford University Press.

Gabrielsson, A. (2010). Strong experiences with music. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, and applications* (pp. 547–574). Oxford University Press.

Geringer, J. M., Madsen, C. K., & Dunnigan, P. (2001). Trumpet tone quality versus intonation revisited: Two extensions. *Bulletin of the Council for Research in Music Education*, 148, 65–76.

Hevner, K. (1936). Experimental studies of the elements of expression in music. *The American Journal of Psychology*, 48(2), 246.

Juslin, P. N. (2013). From everyday emotions to aesthetic emotions: Towards a unified theory of musical emotions. *Physics of Life Reviews*, 10(3), 235–266.

Juslin, P. N. (2016). Emotional reactions to music. In S. Hallam, I. Cross, & M. Thaut (Eds.), *The Oxford handbook of music psychology* (2nd ed., pp. 197–213). Oxford University Press.

Juslin, P. N., & Sloboda, J. A. (Eds.). (2010). *Handbook of music and emotion: Theory, research, and applications.* Oxford University Press.

Quinto, L., Thompson, W. F., & Taylor, A. (2014). The contributions of compositional structure and performance expression to the communication of emotion in music. *Psychology of Music*, 42(4), 503–524.

Smith, J. (1999). Movie music as moving music: Emotion, cognition, and the film score. In C. R. Plantinga & G. M. Smith (Eds.), *Passionate views: Film, cognition, and emotion.* Johns Hopkins University Press.

Sundberg, J., Lã, F. M. B., & Himonides, E. (2013). Intonation and expressivity: A single case study of classical Western singing. *Journal of Voice*, 27(3), 391.e1-391.e8.

Vurma, A., & Ross, J. (2006). Production and perception of musical intervals. *Music Perception*, 23(4), 331–344.

The effects of variable latency timings and jitter on networked musical performances

Huw Cheston, Ian Cross, Peter Harrison

Centre for Music and Science, University of Cambridge, Cambridge, United Kingdom

BACKGROUND
Performing together remotely presents challenges for musicians, most notably in accommodating the temporal delay (or latency) that is introduced whenever data is transferred over a network (Driessen et al., 2011). During experiments, researchers have traditionally emulated the behaviour of networks by introducing a constant, unchanging delay into the audio and/or video feedback a musician receives from their co-performers (Bartlette et al., 2006). In reality, the amount of latency experienced during telecommunication is rarely as consistent as this, with transmission errors and network congestion often causing latency to vary above a fixed, baseline value (Rottondi et al., 2016). This variation is known as 'jitter'.

AIMS
This research aimed to understand how the presence and amount of jitter could affect the ability of an ensemble to make music together over a network. We considered the degree of jitter that musicians could tolerate, alongside its effect on both the stability of their performance and their subjective evaluation of it.

METHOD
We addressed these research aims by developing and testing a realistic implementation of the typical latency and jitter experienced during a networked musical performance. A model of network latency was generated by repeated comparison of the remote reception of an isochronous source on a real telecommunication system with the temporal structure of its original. Using a novel software testbed, this model could then be manipulated, either by adjusting the baseline latency or the amount of jitter present. We then applied this telecommunication model to a series of performances made by professional jazz musicians under experimental conditions. From each performance, we obtained individual BPM measurements alongside self-evaluation ratings of performance success and inter-ensemble coordination. We measured the effect of increases in latency and jitter on tempo slope (the linear tendency towards acceleration or deceleration) and stability (the moment-to-moment variability of tempo), alongside their impact on the self-evaluation responses.

RESULTS
Pilot results showed that both the latency and the jitter components of our model negatively impacted the performance features we measured. Latency caused a general deceleration (negative tempo slope), which was maximal at 90 milliseconds of delay; at higher latencies, participants no longer decelerated. Participant self-evaluations reflected this negative effect, with increases in latency up to 90 ms causing decreases in ratings of performance success and communication ease. Jitter did not cause any systematic tempo change. However, Granger causality analyses showed that performers commonly sped up and slowed down to follow the jitter trajectory. Participant self-evaluations confirmed that increasing amounts of jitter negatively affected the ease of coordinating with a partner.

DISCUSSION
Given the exponential growth in the use of telecommunication since the COVID-19 pandemic (Garg et al., 2022), understanding how these platforms may affect musical performances is important. Our findings demonstrate that even small amounts of jitter contribute to substantial decreases in the stability of a performance, no matter the baseline degree of latency present. We thus suggest that the developers of telecommunication platforms may need to find ways to mitigate the presence of jitter, such as by incorporating network buffers of consistent size.

REFERENCES
Bartlette, C., Headlam, D., Bocko, M., & Velikic, G. (2006). Effect of network latency on interactive musical performance. *Music Perception, 24*(1), 49–62. https://doi.org/10.1525/mp.2006.24.1.49
Driessen, P. F., Darcie, T. E., & Pillay, B. (2011). The effects of network delay on tempo in musical performance. *Computer Music Journal, 35*(1), 76–89. https://doi.org/10.1162/COMJ_a_00041
Garg, S., Srivastava, A., Glencross, M., & Sharma, O. (2022). A study of the effects of network latency on visual task performance in video conferencing. *CHI Conference on Human Factors in Computing Systems Extended Abstracts*, 1–7. https://doi.org/10.1145/3491101.3519678
Rottondi, C., Chafe, C., Allocchio, C., & Sarti, A. (2016). An overview on networked music performance technologies. *IEEE Access, 4*, 8823–8843. https://doi.org/10.1109/ACCESS.2016.2628440

Investigating the effect of feedback in music performance anxiety

Laura M. Damm, Maria Herrojo Ruiz

Goldsmiths University of London, London, United Kingdom

BACKGROUND

Musicians with music performance anxiety (MPA) experience anxiety symptoms in face of music performance, despite being familiar with the situation (Fernholz et al., 2019). MPA expresses itself in both cognitive and somatic symptoms like trembling hands or increased self-doubt, which can negatively affect a music performance (Gelenberg, 2000). Both behavioural and physiological factors weigh into this phenomenon. Previous behavioural research found that individuals with anxiety respond more to negative feedback regarding their performance, than to positive feedback and show increased motivation to improve as to receive positive feedback in the future (Alyward et al., 2019; Hoang & Sharpe, 2021). Neuroscientific research further found that individuals going through temporary states of anxiety exhibit an abnormal increase in the amplitude of one particular brain rhythm, beta oscillations (13-30 Hz), during processing reward feedback (Sporn et al., 2020). This amplitude enhancement was associated with reduced updates in motor predictions and poorer feedback-based motor learning overall (Sporn et al., 2020). Beta oscillations in sensorimotor areas are considered to be relevant to maintaining the current state of the motor system, with updates in motor learning associated with decreased beta amplitude (Engel & Fries, 2010). This suggests that assessing beta oscillatory activity during feedback processing to guide learning could reveal abnormal feedback-processing mechanisms in musicians with MPA.

AIMS

This study investigates if pianists with higher relative to lower MPA learn more from negative feedback than from positive feedback and whether this effect is associated with changes in cortical beta oscillatory activity.

METHOD

Forty pianists with at least 6 years of experience will complete a feedback-based piano performance task over two blocks. Their aim is to infer the target dynamics of two different melodies. One feedback block will provide trial-wise negative feedback with decreasing points (0 to –100), while the other block will give trial-wise positive feedback in form of increasing points (0 to 100). We will record electroencephalography (EEG) during task performance. The design is a mixed between-within-subject design, anxiety being the between-subject group and feedback being the within-subject group. Beta oscillations will be analysed during the time interval corresponding to the processing of feedback in each feedback block.

RESULTS

We expect to find that participants with higher relative to lower will require fewer attempts to get closer to the target dynamic during the negative feedback block than they will during the positive feedback block. Furthermore, we expect to observe that beta oscillations in participants with lower MPA remain downregulated during feedback processing, unlike the beta oscillations we expect to observe in participants with MPA. Here we expect to observe beta oscillations entering the upper beta range during feedback processing. These expectations are based on previous research on this topic (Sporn et al., 2020).

DISCUSSION

Current results suggest that pianists learn quicker from positive than from negative feedback, which is not conclusive with previous research. A RM-ANOVA of the binned data in negative and positive feedback suggests that neither the time point, nor the interaction of time and feedback type are significantly affecting the scores, but the type of feedback alone does. This indicates that improvement depends on the type of feedback and that neither positive nor negative feedback are currently engaged in learning acceleration. This observation is further supported by the steady amount of pitch errors made across 100 trials in both feedback categories.

REFERENCES

Aylward, J., Valton, V., Ahn, W. Y., Bond, R. L., Dayan, P., Roiser, J. P., & Robinson, O. J. (2019). Altered learning under uncertainty in unmedicated mood and anxiety disorders. *Nature Human Behaviour*, *3*(10), 1116-1123. https://doi.org/10.1038/s41562-019-0628-0

Engel, A. K., & Fries, P. (2010). Beta-band oscillations-signalling the status quo? *Currentas Opinion in Neurobiology*, *20*(2), 156–165. https://doi.org/10.1016/j.conb.2010.02.015

Fernholz, I., Mumm, J. L., Plag, J., Noeres, K., Rotter, G., Willich, S. N., … Schmidt, A. (2019). Performance anxiety in professional musicians: A systematic review on prevalence, risk factors and clinical treatment effects. *Psychological Medicine*, *49*(14), 2287-2306.

Gelenberg, A. J. (2000). Psychiatric and somatic markers of anxiety: identification and pharmacologic treatment. *Primary Care Companion to the Journal of Clinical Psychiatry*, *2*(2), 49.

Hoang, I. B., & Sharpe, M. J. (2021). The basolateral amygdala and lateral hypothalamus bias learning towards motivationally significant events. *Current Opinion in Behavioral Sciences*, *41*, 92–97.

Sporn, S., Hein, T., & Ruiz, M. H. (2020). Alterations in the amplitude and burst rate of beta oscillations impair reward-dependent motor learning in anxiety. *eLife*, *9*, e50654. https://doi.org/10.7554/elife.50654

Do musicians outperform non-musicians in foreign language prosody production?

Lidwin Dejans, Pauline Degrave

Université Catholique de Louvain, Louvain-la-Neuve, Belgium

BACKGROUND

In recent years, the relationship between music and language has received increasingly more attention, resulting in multiple studies analysing the impact of music training or musical skills on different domains of foreign language acquisition, such as phonological skills (Milovanov et al., 2010; Slevc et al., 2006), vocabulary (Swaminathan et al., 2013) and prosody perception (Degrave, 2020). However, studies addressing the influence of music on prosody production in a foreign language are rather scarce (Gralińska-Brawata et al., 2017) and the main studies in the field of prosody address the acquisition of English (Marie et al., 2011), Mandarin (Cason et al., 2020) and Spanish (Dupoux et al., 2008). Prosody encompasses "all sound properties of an utterance that are not related to those of its vowels and consonants" (Rietveld et al., 2016) and constitutes the "melodic and rhythmic framework" of an oral utterance (Degrave, 2021). The acquisition of Dutch is especially interesting since prosodic differences with French typically cause problems in acquiring spoken Dutch (Rietveld et al., 2016; Rasier, 2006). Recent research has studied the perception and production of Dutch word and sentence stress by francophone learners (Rietveld et al., 2016; Degrave, 2019; Michaux et al., 2013). Dutch stress is variable, and thus less predictable than the fixed stress in French, and has different functions, i.e., carrying lexical information or structuring information in a sentence (Rietveld et al., 2016). Moreover, erroneous stress placement has been found to impair intelligibility and comprehension (Michaux et al., 2015). Hence, this study focuses on the production of Dutch prosody (word and sentence stress) by French-speaking musicians and non-musicians.

AIMS

The present study investigates the differences between the Dutch prosody production by French-speaking musicians and non-musicians.

METHOD

The present study includes 20 practicing musicians, with at least 5 years of music lessons, and 20 non-musicians, who have had a maximum of 2 years of music education at least 8 years ago. The participants are monolingually raised with French as their native language, have an intermediate level of Dutch (between A2 and B2), and benefit from a similar exposure to Dutch (e.g., no intensive daily contact with Dutch for more than 6 months and no immersion schools). The control group consists of 10 native speakers of Dutch with a similar profile (5 musicians, 5 non-musicians).

We also collect data on the participants' musical skills through a singing task and on their proficiency level in Dutch using DIALANG subtests (Huhta et. al 2002) and LexTALE (Lemhöfer et al., 2012). The prosody production task, based on (Degrave, 2019; Michaux et al., 2014; Boersma et al., 2022), tests the participants' production of respectively Dutch word stress and sentence stress. A double analysis will be performed on the productions: 3 native speakers of Dutch will evaluate the accuracy of the stress placement, and the productions will also be analysed acoustically using PRAAT (Boersma et. al, 2022). For the statistical analyses of the data, we will use a Two-Sample T-Test. We also used this test to verify that there is no significant difference in language proficiency between the two groups.

RESULTS

The data analysis is currently in progress (March-May 2022). We expect the production of Dutch prosody to be more nativelike in musicians than in non-musicians.

DISCUSSION

The results of the present study will be discussed in relation to the existing literature concerning the linguistic performance of musicians and non-musicians.

REFERENCES

Boersma, P., & Weenink, D. (2022). Praat: doing phonetics by computer (Version 6.2.08) [Computer Program]. http://www.praat.org

Cason, N., Marmursztejn, M., D'Imperio, M., & Schön, D. (2020). Rhythmic abilities correlate with l2 prosody imitation abilities in typologically different languages. *Language and Speech*, 63(1), 149–165.

Degrave, P. (2019). *Music and the perception of foreign language stress* [Doctoral dissertation]. Université Catholique de Louvain.

Degrave, P. (2020). Music training and the use of songs or rhythm: Do they help for lexical stress processing?. *International Review of Applied Linguistics in Language Teaching*.

Degrave, P. (2021). The contribution of prosody to intelligibility, comprehensibility and accentedness in foreign language acquisition. *Nederlandse Taalkunde*, 26(2), 273-298.

Dupoux, E., Sebastián-Gallés, N., Navarrete, E., & Peperkamp, S. (2008). Persistent stress "deafness": The case of French learners of Spanish. *Cognition*, 106(2), 682–706.

Gralińska-Brawata, A., & Rybińska, P. (2017). The relationship between the production of word stress and musical

abilities in Polish learners of English. *Research in Language*, 15(3), 265–283.

Huhta, A., Luoma, S., Oscarson, M., Sajavaara, K., Takala, S., & Teasdale, A. (2002). DIALANG: A diagnostic language assessment system for learners. In J. C. Alderson (Ed.), *Case studies of the Use of the Common European Framework* (pp. 130–145). Council of Europe.

Lemhöfer, K., & Broersma, M. (2012). Introducing LexTALE: A quick and valid lexical test for advanced learners of English. *Behavior Research Methods*, 44, 325–343. https://doi.org/10.3758/s13428-011-0146-0

Marie, C., Delogu, F., Lampis, G., Belardinelli, M. O., & Besson, M. (2011). Influence of musical expertise on segmental and tonal processing in Mandarin Chinese. *Journal of Cognitive Neuroscience*, 23(10), 2701–2715. https://doi.org/10.1162/jocn.2010.21585

Michaux, M.-C., & Caspers, J. (2013). The production of Dutch word stress by Francophone learners. In P. Mertens & A. C. Simon (Eds.), *Proceedings of the Prosody-Discourse Interface Conference 2013* (IDP-2013) (pp. 89–94). Franitalco. http://hdl.handle.net/2078.1/144065

Michaux, M.-C., Brognaux, S., & Christodoulides, G. (2014). The production and perception of L1 and L2 Dutch stress. In N. Campbell, D. Gibbon, & D. Hirst (Eds.), *Proceedings of the 7th Speech Prosody Conference (pp. 1002–1006).* Trinity College. https://doi.org/10.13140/2.1.3323.0727

Michaux, M.-C., van Heuven, V., & Hiligsmann, P. (2015). Effects of hearing an incorrect stress on word naming in Dutch by Francophones. In The Scottish Consortium for ICPhS 2015 (Ed.), *Proceedings of the 18th International Congress of Phonetic Sciences.*

Milovanov, R., Pietilä, P., Tervaniemi, M., & Esquef, P. A. A. (2010). Foreign language pronunciation skills and musical aptitude: A study of Finnish adults with higher education. *Learning and Individual Differences*, 20(1), 56–60. https://doi.org/10.1016/j.lindif.2009.11.003

Rasier, L. (2006). *Prosodie en vreemdetaalverwerving. Accentdistributie in het Frans en het Nederlands als vreemde taal* [Unpublished doctoral dissertation]. Université Catholique de Louvain.

Rietveld, A. M. C., & van Heuven, V. J. (2016). *Algemene Fonetiek* (3rd rev. ed.). Coutinho.

Slevc, L. R., & Miyake, A. (2006). Individual differences in second-language proficiency: Does musical ability matter?. *Psychological Science*, 17(8), 675–681. https://doi.org/10.1111/j.1467-9280.2006.01765.x

Swaminathan, S., & Gopinath, J. K. (2013). Music training and second-language English comprehension and vocabulary skills in Indian children. *Psychological Studies*, 58(2), 164–170.

Covid-19-Version-Songs: Emergence, characteristics, and receptions of a new kind of musical contrafactum

Jan Eggert[1], Hannah Fiehn[2], Emily Gernandt[3,4], Nikita Kudakov[3,2], Melanie Wald-Fuhrmann[3]

[1]Johannes Gutenberg-University Mainz, Mainz, Germany.
[2]Goethe-University Frankfurt am Main, Frankfurt am Main, Germany.
[3]Max-Planck-Institute for Empirical Aesthetics, Frankfurt am Main, Germany.
[4]University of Kassel, Kassel, Germany

BACKGROUND

Since the beginning of the coronavirus pandemic, different musical forms have emerged around the world in response to the situation. One particularly popular form can be described as contrafacta: a compositional technique characterised by the layering of a new text on existing musical material (Dadelsen, 1997; Falck, 1979). Numerous new music videos of this type have been created during the pandemic and uploaded to the YouTube video platform.

AIMS

This project aims to understand the musical and lyrical aspects of the corona-related contrafacta and the effect contrafacta have on viewers.

METHOD

Using a systematic YouTube search based on the keywords "Covid-19 version song", "Corona parody song", and "song lockdown version" the most relevant videos between October 30 and November 20, 2020, were collected (N = 120). Subsequently, these results were narrowed down to German- and English-language videos, resulting in a final sample of n = 57 songs to be analysed. Using a qualitative content analysis (Mayring, 2015), the songs were examined for recurring song content (narrative perspective, valence, lyrics), style, musical and visual arrangement. In addition, YouTube comments (N = 560), focusing on those with the highest relevance were collected. Thereby "relevance" was defined by the "top comments" displayed by the YouTube algorithm.

RESULTS

The majority of contrafacta are popular songs from the genres of musicals and soundtracks (n = 20), pop (n = 14), and rock (n =13) and are thus familiar to a wide audience. The contrafacta often address the community, but also report individual experiences through the lyrical "I." While the original songs present a high complexity of different themes and expressions, the contrafacta, due to their rewording, often feature a recurring, humorous take on the pandemic. The majority of comments on the contrafacta related to aspects of the artwork, such as the video, the music, or the text (n = 303), and had a positive association (n = 105). Ninety-eight comments were used to communicate with the artists and other YouTube users and n = 73 comments were related to sharing experiences.

DISCUSSION

It can be summarised that the sense of community is the main aspect of the creation and reception of the contrafacta. This dataset and corresponding analyses lay the foundation for a variety of future related work to examine more deeply the compositional techniques and reception of contrafacta, as well as the important role that such music plays in helping communities cope with societal crises.

REFERENCES

Dadelsen, G. von. (1997). Parodie und kontrafaktur. In L. Lütteken (Hrsg.), *Musik in Geschichte und Gegenwart (Bd. 1)*. Bärenreiter and Metzler and RILM. https://www.mgg-online.com/mgg/stable/14062

Falck, R. (1979). Parody and contrafactum: A terminological clarification. *The Musical Quarterly, 65*(1), 1–21.

Mayring, P. (2015). *Qualitative inhaltsanalyse: grundlagen und techniken*. Beltz Verlag.

Electrophysiological correlates of group musical engagement during a live dance performance

Adam A. Garrow, Guido Orgs, Laura Rai

Goldsmiths, University of London, London, United Kingdom

BACKGROUND

Music is often experienced live (Freeman, 2000; Nettl & Russell, 1998), even when alternative consumption methods exist, and music at live events can elicit powerful affective responses in audience members (Cotter et al., 2018; Mori & Iwanaga, 2017) through their shared experiences when interacting with performers (Leante, 2017; Silverberg et al., 2013) and/or other audience members (Brown & Knox, 2017; Burland & Pitts, 2016). Hyperscanning, the simultaneous measurement of multiple individuals' brain activities (Czeszumski et al., 2020), can be used to assess neurological correlates of such aesthetic experiences; electroencephalography (EEG) hyperscanning lets us assess neural synchrony with excellent temporal resolution during shared activities in naturalistic and ecologically valid settings (Acquadro et al., 2016; Dmochowski et al., 2012, 2014). Existing EEG hyperscanning studies report elevated neural synchrony in listeners at musically salient points in pre-recorded music (Kaneshiro et al., 2021), yet liveness' role in shared musical engagement is yet to be studied.

AIMS

We will assess neural synchrony among audience members for different versions of Detective Work, a 17-section dance choreography with an original soundtrack; we predict that audiences' global and intra-section EEG inter-subject correlations (ISCs) will be higher during the live performance than an audio-visual recording of the performance. We will further test to what extent neural synchrony uniquely varies with pre-selected musical features during live and recorded versions of the performance.

METHOD

Notable musical features of the performance will be selected a priori using MIRtoolbox, a computational method for extracting saliencies of musical features from audio files (Lartillot et al., 2008), and notable visual features will be selected based on motion-tracking data from the dancers' movements. N = 90 healthy adults will be recruited via convenience sampling from near Goldsmiths, University of London. Participants will complete a pre-performance questionnaire recording dance and music backgrounds and will then be randomly allocated to an audience (n = 15) for one of two screening types of Detective Work: live or pre-recorded. During screenings, participants will be fitted with portable 32-channel EEG headsets to record continuous EEG time series; these data will be pre-processed, stored, and timestamped for synchronized playback with performance stimuli. Participants will then complete a post-performance questionnaire asking for their evaluations of Detective Work.

RESULTS

Pairwise EEG ISC calculations will use the circular correlation coefficient (CCorr) to minimize instances of spurious hyperconnectivity (Burgess, 2013) and whole-audience EEG ISCs calculations will use the total interdependence (TI) measure (Wen et al., 2012). We will assess group differences in global EEG ISCs using a one-way ANCOVA, with follow-up contrasts between audiences' intra-section EEG ISCs in live and recorded conditions. We will exploratively assess EEG regions of interest for moments of elevated ISCs in live and recorded conditions using Reliable Components Analysis (RCA) (Dmochowski et al., 2012), with follow-up contrasts between ISCs identified by RCA versus ISCs at pre-selected auditory and visual events.

DISCUSSION

This research may identify moments of shared musical engagement unique to a live music-cantered performance and elucidate potential neurological substrates for facilitating such collectivist responses in an audience.

REFERENCES

Acquadro, M. A. S., Congedo, M., & De Riddeer, D. (2016). Music performance as an experimental approach to hyperscanning studies. *Frontiers in Human Neuroscience*, 10.

Brown, S. C., & Knox, D. (2017). Why go to pop concerts? The motivations behind live music attendance. *Musicae Scientiae*, 21(3), 233–249. https://doi.org/10.1177/1029864916650719

Burgess, A. P. (2013). On the interpretation of synchronization in EEG hyperscanning studies: A cautionary note. *Frontiers in Human Neuroscience*, 7. https://doi.org/10.3389/fnhum.2013.00881

Burland, K., & Pitts, S. (Eds.). (2016). *Coughing and clapping: Investigating audience experience* (1st ed.). Routledge. https://doi.org/10.4324/9781315574455

Cotter, K. N., Silvia, P. J., & Fayn, K. (2018). What does feeling like crying when listening to music feel like? *Psychology of Aesthetics, Creativity, and the Arts*, 12(2), 216–227. https://doi.org/10.1037/aca0000108

Czeszumski, A., Eustergerling, S., Lang, A., Menrath, D., Gerstenberger, M., Schuberth, S., … König, P. (2020). Hyperscanning: A valid method to study neural inter-brain underpinnings of social interaction. *Frontiers in Human Neuroscience*, 14, 39. https://doi.org/10.3389/fnhum.2020.00039

Dmochowski, J. P., Bezdek, M. A., Abelson, B. P., Johnson, J. S., Schumacher, E. H., & Parra, L. C. (2014). Audience preferences are predicted by temporal reliability of neural processing. *Nature Communications*, 5(1), 4567. https://doi.org/10.1038/ncomms5567

Dmochowski, J. P., Sajda, P., Dias, J., & Parra, L. C. (2012). Correlated components of ongoing EEG point to emotionally laden attention – A possible marker of engagement? *Frontiers in Human Neuroscience*, 6.

Freeman, W. J. (2000). A neurobiological role of music in social bonding. In *The Origins of Music* (pp. 411–424).

Kaneshiro, B., Nguyen, D. T., Norcia, A. M., Dmochowski, J. P., & Berger, J. (2021). Inter-subject EEG correlation reflects time-varying engagement with natural music. *BioRxiv*.

Lartillot, O., Toiviainen, P., & Eerola, T. (2008). A Matlab toolbox for music information retrieval. In C. Preisach, H. Burkhardt, L. Schmidt-Thieme, & R. Decker (Eds.), *Data analysis, machine learning and applications* (pp. 261–268). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-78246-9_31

Leante, L. (2017). *Musicians and their audiences: Performance, speech and mediation* (I. Tsioulakis & E. Hytönen-Ng, Eds.). Routledge.

Mori, K., & Iwanaga, M. (2017). Two types of peak emotional responses to music: The psychophysiology of chills and tears. *Scientific Reports*, 7(1), 46063. https://doi.org/10.1038/srep46063

Nettl, B., & Russell, M. (Eds.). (1998). *In the course of performance: Studies in the world of musical improvisation*. University of Chicago Press.

Silverberg, J. L., Bierbaum, M., Sethna, J. P., & Cohen, I. (2013). Collective motion of humans in mosh and circle pits at heavy metal concerts. *Physical Review Letters*, 110(22), 228701.

Wen, X., Mo, J., & Ding, M. (2012). Exploring resting-state functional connectivity with total interdependence. *NeuroImage,* 60(2), 1587–1595. https://doi.org/10.1016/j.neuroimage.2012.01.079

Are sad music lovers self-compassionate? Exploring the relationship between self-compassion and sad music preference

Tomasz Gąsior

Silesian University, Katowice, Poland

BACKGROUND

As replicated in several studies, higher empathy and compassion traits are more common among people who enjoy sad music (Huron & Vuoskoski, 2020). Sad music lovers tend to sympathise with the feelings of others (e.g., the artist, performer, or protagonist of the story) while experiencing only a moderate level of emotional distress. Despite the proven relationship with empathetic traits, there is little knowledge about the self-compassionate approach to sad music. Self-compassion might be an important trait of sad music lovers in their use of music. Studies showed that listening to self-identified sad music after an adverse event was related to acceptance-based coping and self-regulatory goals like re-experiencing affect (Van den Tol & Edwards, 2013; Van den Tol et al., 2016). Additionally, people tend to seek validation of emotions and solace through sad music (Saarikallio & Erkkilä, 2007; Hanser et al., 2016) and regulate their negative feelings and emotions with it (Taruffi & Koelsch, 2014).

AIMS

The study explores the relationship between sad music preference, self-compassion and its components: self-kindness, self-judgment, common humanity, isolation, mindfulness and over-identification. Additionally, I wanted to explore the relationships between psychological functions of music listening, strategies of mood regulation through music and sad music preference and see if there is a difference in all of those variables between people with a low and high preference for sad music.

METHOD

274 participants filled in an online survey with sad music preference questions, SCSPL, MMRPL, Psychological Functions of Music Listening Scale and one open-ended question about their relationship with sad music.

RESULTS

Sad music (SM) preference correlated negatively with self-compassion ($r = -0.138$, $p < 0.05$) and positively with two subscales: isolation ($r = 0.190$, $p < 0.01$) and over-identification ($r = 0.194$, $p < 0.01$). SM preference also correlated positively with the use of music for mental work/solace ($r = 0.301$, $p < 0.001$) and strong sensation ($r = 0.247$, $p < 0.001$). Self-awareness, a function of music listening was correlated positively with sad music preference ($r = 0.258$, $p < 0.001$). All of the observed correlations were weak. To check the differences in studies' variables between people with high and low preference for sad music, the group was split using 25% of the lowest and 25% of the highest results on the sad music preference question. The U Mann-Whitney test showed significant differences between people with a high and low preference for sad music with low to moderate effect sizes in: self-awareness (rbs = 0.385), isolation (rbs = 0.268), over-identification (rbs = 0.204), mental work-solace (rbs = 0.437) and strong sensation (rbs = 0.410).

DISCUSSION

These results might help understand the functioning of people with a high preference for sad music. Sad music lovers tend to engage in mental work and seek solace through music more than people with lower sad music preference but are more likely to stay with their thoughts and feelings alone and over-identify with them. Future research should focus more on sad music listeners' actual mental health benefits.

REFERENCES

Hanser, W. E., Bogt, T. F., van den Tol, A. J. M., Mark, R. E., & Vingerhoets, A. J. J. M. (2016). Consolation through music: A survey study. *Musicae Scientiae*, 20(1), 122–137.

Huron, D., & Vuoskoski, J. K. (2020). On the enjoyment of sad music: Pleasurable compassion theory and the role of trait empathy. *Frontiers in Psychology*, 11, 1060. https://doi.org/10.3389/fpsyg.2020.01060

Saarikallio, S., & Erkkilä, J. (2007). The role of music in adolescents' mood regulation. *Psychology of Music*, 35(1), 88–109. https://doi.org/10.1177/0305735607068889

Taruffi, L., & Koelsch, S. (2014). The paradox of music-evoked sadness: an online survey. *PloS One*, 9(10), e110490.

Van den Tol, A. J. M., & Edwards, J. (2013). Exploring a rationale for choosing to listen to sad music when feeling sad. *Psychology of Music*, 41(4), 440–465. https://doi.org/10.1177/0305735611430433

Van den Tol, A. J. M., & Edwards, J., & Heflick, N. A. (2016). Sad music as a means for acceptance-based coping. *Musicae Scientiae*, 20(1), 68–83. https://doi.org/10.1177/1029864915627844

Discrete or dimensional: A comparison of methodological approaches to quantify affect

Iza R. Korsmit, Marcel Montrey, Alix Yok Tin Wong-Min, Stephen McAdams
McGill University, Montreal, Canada

BACKGROUND
The best methodology to quantify perceived and induced affect remains a point of discussion in music research and affect research more generally. The theoretical debate over emotion as innate basic categories (Panksepp, 2007) versus a two- or three-dimensional model of affect (Eerola et al., 2012; McAdams et al., 2017; Russell, 1980; Schimmack & Grob, 2000) is at the heart of this discussion. The conceptual act model may reconcile the discrete and dimensional approaches by suggesting that, at its core, affect is a multidimensional concept but is conceptualised by humans using categorical emotion terms (Barrett, 2004; Cespedes-Guevara & Eerola, 2018).

AIMS
This work is part of a larger project that sets out to examine the effects of pitch, instrument family, and timbre on affect, as well as the mediating role of individual differences in these effects. Here, we explore the relative performance of dimensional and discrete affect quantifications, such that researchers may be better informed in choosing suitable methodological approaches. We compare the two self-report measures for perceived and induced affect using single-note and chromatic-scale excerpts.

METHOD
Two experiments were set up online. In both experiments, participants (n_1 = 263, n_2 = 152) rated either perceived or induced affect on either three-dimensional (valence, tension arousal, energy arousal) or discrete (sadness, happiness, anger, fear, tenderness) scales. In experiment 1, the 59 stimuli consisted of single notes. In experiment 2, the 32 stimuli consisted of chromatic scales spanning a perfect fifth. In both experiments, stimuli varied in pitch register and instrument family.

RESULTS
In both experiments, valence and tension arousal were highly correlated (r_1 = −.93, r_2 = −.96), more strongly for induced than perceived affect. Anger and fear (r_1 = .89, r_2 = .90), anger and tenderness (r_1 = −.89, r_2 = −.92), and tenderness and happiness (r_1 = .92, r_2 = .94) were also highly correlated, overall, more strongly for perceived than induced affect. These correlations were stronger in experiment 2 (chromatic scales) than in experiment 1 (single notes). We used lasso regression to identify predictive relationships between the discrete and dimensional scales. Valence and tension arousal were predicted by a combination of discrete scales in both experiments (average R^2 = .90), but energy arousal was not (R^2_1 = .08 , R^2_2 = .33). Conversely, a combination of valence and energy predicted most discrete scales well (average R^2 = .81) but performed slightly worse for sadness (R^2_1 = .51, R^2_2 = .49). For both experiments, visual mapping showed that energy arousal captured variation in affect that was not measured by any of the discrete scales.

DISCUSSION
In this project, there was high collinearity for several scales in the dimensional and discrete affect models. We suggest that for experiments using affectively ambiguous stimuli, either single notes or chromatic scales that vary in pitch register and instrument family, a two-dimensional representation of valence and energy arousal best captures the affective variation. This is especially the case for induced affect, although the differences are not large. Two-dimensional representations also require the least cognitive load for participants.

REFERENCES
Barrett, L. F. (2004). Feelings or words? Understanding the content in self-report ratings of experienced emotion. *Journal of Personality and Social Psychology, 87(2)*, 266–281.

Cespedes-Guevara, J., & Eerola, T. (2018). Music communicates affects, not basic emotions – A constructionist account of attribution of emotional meanings to music. *Frontiers in Psychology, 9*, 1–19.

Eerola, T., Ferrer, R., & Alluri, V. (2012). Timbre and affect dimensions: Evidence from affect and similarity ratings and acoustic correlates of isolated instrument sounds. *Music Perception: An Interdisciplinary Journal, 30(1)*, 49–70. https://doi.org/10.1525/mp.2012.30.1.49

McAdams, S., Douglas, C., & Vempala, N. N. (2017). Perception and modeling of affective qualities of musical instrument sounds across pitch registers. *Frontiers in Psychology, 8*, 1–19.

Panksepp, J. (2007). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can coexist. *Perspectives on Psychological Science, 2(3)*, 281–296.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39(6)*, 1161–1178.

Schimmack, U., & Grob, A. (2000). Dimensional models of core affect: A quantitative comparison by means of structural equation modeling. *European Journal of Personality, 14*, 325–345.

Identifying Peking opera roles through vocal timbre: An acoustical and conceptual comparison between laosheng and dan

Annie Liu, Zachary Wallmark

University of Oregon, Eugene, USA

BACKGROUND

Peking opera, or *jingju*, originated in regional theater during the mid-Qing dynasty and rose to become China's national style during the nineteenth century. *Jingju* incorporates speech, song, and complex costuming and makeup in dramatic narratives led by several stock personae. Lau (2007) describes these character types as differentiated chiefly by "vocal style, identified by timbre, voice quality, volume, and manner of enunciation." However, the way vocal timbre contributes to *jingju* characterization and narrative function is relatively uncharted: researchers have analysed vibrato usage and laryngeal positioning in *jingju* singers, but not the specific timbral attributes that constitute these characters' vocal styles.

AIMS

This paper examines the acoustic and semantic timbral attributes of two *jingju* character types: *laosheng* (refined older man) and *dan* (woman). Our project was motivated by two questions: 1) What acoustic and semantic commonalities or distinctions exist between *laosheng* and *dan* timbres? and 2) How might *laosheng* and *dan* vocal timbres reinforce each role's identity or narrative function?

METHOD

We examined a corpus of *jingju* recordings created by Gong et al. (2017) to compute spectral profiles of typical *laosheng* and *dan* singing. We analysed consistencies in spectral peak, envelope, and energy distribution between the voice types. We are currently using the three-dimensional timbre semantics model of Zacharakis et al. (2014) to gather listeners' ratings of luminance (brilliant versus less brilliant), texture (smooth versus rough), and mass (full versus light) for the voice roles.

RESULTS

Spectrograms reveal differences in energy distribution across harmonic partials and spectral envelopes: *laosheng* displays a more even spectral distribution and greater inharmonicity, while *dan* shows concentrated energy in lower frequencies with less harmonic distortion. *Laosheng* envelopes showed higher harmonics gradually entering during the attack and collectively rising during the decay, whereas *dan* envelopes had all harmonics present at the attack and collectively falling during the decay. Pilot results for semantic descriptors for luminance, mass, and texture indicate both types are "brilliant," but *laosheng* timbre is "rough and full" whereas *dan* timbre is "smooth and light."

DISCUSSION

Timbral differences between *jingju* vocal roles support the characters' narrative functions, casting *laosheng* as wise and seasoned and *dan* as sweet and elegant. Both the acoustical properties and semantic descriptors reveal systematic connections between timbre and character type that provide auditory identification, affective cues, and narrative information to a listener, supplementing the visual stimulus and representing the character type through sound. Future directions include broadening the scope of recordings and analysing additional roles (e.g., *jing* and *chou*). This project adds to the growing literature on *jingju* (Peking opera) by demonstrating the affective significance of timbre in the differentiation of vocal roles.

REFERENCES

Gong, R., Caro Repetto, R., & Serra, X. (2017, October 28). *Creating an a cappella singing audio dataset for automatic jingju singing evaluation research* [Conference presentation]. The 4th International Digital Libraries for Musicology Workshop, Shanghai, China. https://doi.org/10.5281/zenodo.1245942

Lau, F. (2008). Beijing Opera: Jingju. In *Music in China: Experiencing music, expressing culture* (pp. 69–74). Oxford University Press.

Zacharakis, A., Pastiadis, K., & Reiss, J. (2014). An interlanguage study of musical timbre semantic dimensions and their acoustic correlates. *Music Perception, 31*(4), 339–58.

Depict or discern? Fingerprinting musical taste from explicit preferences

<u>Kristina Matrosova</u>[1,2,3], Manuel Moussallam[3], Thomas Louail[1], Olivier Bodini[2]
[1]Géograpie-cités, Aubervilliers, France.
[2]LIPN, Villetaneuse, France.
[3]Deezer, Paris, France

BACKGROUND

Research on musical taste spans over a large body of scientific disciplines. From a sociological standpoint, musical taste has been long identified as an important, self-claimed, differentiating feature among individuals (Bourdieu, 1987). Psychological studies have been investigating positive correlations between musical preferences and personality traits (North, 2010). More recently, the concept has been used in the music recommender system literature (Schedl, 2015), as the distinctive part of the musical space from which a user is likely to enjoy a recommendation. In its general understanding, musical taste is an individual's set of musical preferences. In that sense, it is a highly personal trait, that uniquely characterize each and every one of us.

AIMS

We work on a dataset of 1M randomly sampled users of the streaming platform Deezer. Our goal is to study musical taste through the users' favourite items (artists and songs). We want to create, for each user, a subset of their favourite items that we call musical taste fingerprint. We look for two distinct types of fingerprints. First, a distinctive fingerprint of minimal size that describes a user's preferences in a unique way. Second, a fingerprint that is representative of the diversity of user's preferences in terms of popularity and music genre.

METHOD

In order to find a minimal size unique fingerprint, we use a greedy approach. The idea is to progressively select user's favourite items that are the less co-liked by all of the users, until the obtained set is unique and belongs exclusively to our user.

To build a representative fingerprint, we perform a k-medoid algorithm of the items, the set of medoids being the fingerprint. We evaluate the performance of this method with a prediction task that consists in recovering the initial set of favourite items from the sampled ones. We perform a k-nearest neighbours algorithm on items embeddings for prediction. We then use three evaluation methods to rate the prediction: comparing items, coverage of genres ratio or popularity ratio.

RESULTS

We show that almost 70% of the users can be identified with their set of favourite songs, and 34% of the users can be identified with only two songs or less. Unsurprisingly, less popular songs are the most discriminating ones, and big genres like hip-hop, pop, rock and electronic music are underrepresented in the unique fingerprints than in all of users' favourite items. Additionally, the prediction task on these fingerprints gives worse results than on a randomly sampled fingerprint. Thus, unique fingerprints are not representative of users' preferences. Our method for representative fingerprints, however, allows to recover an average of 15% of a user's library, and an average of 50% of the genre ratio of their favourite items.

DISCUSSION

Building on a large set of literature, we emphasise how preferences elicitation encompass several conflicting definitions. We show that the constraints of uniqueness and representativeness lead to diverging solutions which in turn suggest that work addressing musical taste should probably reflect on their exact objectives. Our experiments are nonetheless limited by the nature of the data used to conduct them. A more promising approach would be to build a richer multi-modal dataset, mixing streaming data to the explicitly liked content.

REFERENCES

Bourdieu, P. (1987). Distinction: A social critique of the judgement of taste. *Harvard University Press*. 33-38.
North, A. C. (2010). Individual differences in musical taste. *The American Journal of Psychology*, 123(2), 199-208.
Schedl, M., Knees, P., McFee, B., Bogdanov, D., & Kaminskas, M. (2015). Music recommender systems. *In Recommender Systems Handbook* (pp. 453-492). Springer, Boston, MA.

Adolescents' music listening for relaxation: Subjective and physiological effects

Gulnara Minkkinen, Suvi Saarikallio, Josefiina Pajunen, Esa Ala-Ruona
University of Jyväskylä, Jyväskylä, Finland

BACKGROUND
Stress is an acute problem for adolescents. Seiffge-Krenke et al. (2009) reported that most adolescents experienced a significant amount of stress during early adolescence. Music is a common resource for relaxation that is actively used by young people (Wells & Hakanen, 1991), but relatively few studies have empirically tested its efficacy for this age group.

AIMS
This study aimed to investigate whether and how self-selected music can facilitate relaxation in adolescents, on both subjective and physiological levels. Three research questions were identified: 1. Does self-selected music promote relaxation (at both subjective and physiological levels) in adolescents? 2. Does music-facilitated relaxation have a stronger effect than a relaxation without music? 3. What kind of music did the participants choose for relaxation purposes and does any particular type of music promote their relaxation better?

METHOD
Twenty-six adolescents participated in two twenty minutes long individual relaxation sessions: one with self-selected relaxation music and one without music. For the No Music condition participants were provided with magazines to read. The heart rate variability (HRV) was measured throughout the experiment, and subjective reports of Valence, Arousal and Tension were collected with visual analogue scales before and after each relaxation session. Participants reported music that they chose in a free form, so some reports included artists and pieces, some included only genres, and some had only general descriptions (e.g., "Radio"). Music chosen by the participants was coded and co-validated by two researchers from the group by genre (where possible) and level of detail in music descriptions, and it was analysed in relation to the HRV. All participants underwent both conditions. A year later the experiment was repeated the same way with the same participants to check the consistency of the results.

RESULTS
HRV was analysed using three parameters: PNS Index, RMSSD and HF. RM ANOVA revealed that both Music and No Music conditions led to significant increase in all three parameters in both years, indicating an increase in relaxation response. Subjective ratings were analysed using Wilcoxon Signed-Rank test; analysis showed significant increase in valence for both conditions and years, and a decrease in tension for the Music condition in both years. Participants felt significantly less tense after Music than after No music condition in the second year (Wilcoxon Signed-Rank test). Music analysis revealed that there were no specific genres that promoted stronger or weaker relaxation response, but more detailed musical descriptions and diversity of genres were connected to stronger relaxation response, indicating that stronger personal relationship to music might lead to better relaxation outcomes in music-facilitated relaxation.

DISCUSSION
Music-facilitated relaxation is cost-efficient and adaptable to the individual intervention for stress reduction, and our findings provide support for the efficacy of music-facilitated relaxation for adolescents. The concept of personal relationship to music deserves thorough examination and consideration from the viewpoints of both theory and practical implication in music-based interventions.

REFERENCES
Seiffge-Krenke, I., Aunola, K., & Nurmi, J.-E. (2009). Changes in stress perception and coping during adolescence: The role of situational and personal factors. *Child Development, 80*(1), 259–279.
Wells, A., & Hakanen, E. A. (1991). The emotional use of popular music by adolescents. *Journalism Quarterly, 68*(3), 445–454. https://doi.org/10.1177/107769909106800315

Methodology of the Digital Score project through an analysis of *Nautilus* case study, an immersive game environment digital score

Solomiya Moroz[1], Craig Vear[2]
[1]De Montfort University, Leicester, United Kingdom.
[2]De Montfort, Leicester, United Kingdom

BACKGROUND
We present the methodology of the Digital Score research project through an analysis of the first case study *Nautilus*. This digital score is part of the research project, developed in collaboration between composer Craig Vear, Unity game designer Adam Stephenson and bass flutist Carla Rees.

AIMS
The focus of the Digital Score theoretical framework is on relationships formed between musicians and the digital score, possibilities for novel creative experiences and how these profoundly influence the nature of digital musicianship. We build on the notion of relationships from Christopher Small's musicking in which 'music is to take part' (Small, 1997). We also expand the framework with the 4Es: embodied, extended, enacted and embedded to which we also add Gordon Calleja's (2011) and Jasper Juul's (2002) notions on evolution and emergence from gaming theory. We hope to show how the data set supports and offers new insight into the Digital Score theoretical framework through a mixed qualitative data set analysis of the *Nautilus* case study.

METHOD
The data for this case study has been collected through a mixed qualitative data set which compared how the digital score was intended by the original creator(s) and received by the performing musician(s) and the audience. The intention vs reception is compared across the lifecycle of the case study looking at the *in-vivo* and *in-vitro* experiences of creators and performers - data collected in the moment of making or performing a digital score, and data as a reflection on this process after the work was completed or performed. The methods of collecting data are also mixed: *in-vitro* using questionnaires, audience surveys and semi-structured interviews, *in-vivo* derived from creators' blogs and stimulated recall interviews with performers. In addition to these methods, a process of induction and deduction is used through the iterative processes of Grounded theory (Glasser, 1992), seeking emergent themes that could complement or challenge the existing framework.

RESULTS
The data set acquired from the case study supports the methodology of the Digital Score and introduces new themes along with the ones considered by the theoretical framework. The themes that emerged through iterative processes are immersion, performers' agency and accessibility. These themes complement those from the theoretical framework. The data from the *in-vitro* and *in-vivo* experiences of the two performers returned similar results supporting the intention/reception methodology spectrum.

DISCUSSION
Through the detailed analysis of the data gathered, researchers gained a deeper understanding of how the methodology supports and enhances the theoretical framework. The new themes which emerged from the novel experiences of musicking and interaction within a game world environment contributed to a fuller understanding of digital scores.

The methodology exposed the problems that other digital scores could run into if they do not take into account communication of the creator's intentions in a collaborative process. Novel experiences of performers in *Nautilus* also provided a positive outlook on the future of musicking with scores that are more accessible to a variety of performers and audiences outside of the Western classical canon.

REFERENCES
Calleja, G. (2011). *In-game: From immersion to incorporation.* MIT Press.

Juul, J. (2002). The open and the closed: Games of emergence and games of progression. *Computer Games and Digital Cultures*, Tampere Finland.

Small, C. (1997). *Musicking: The meaning of performing and listening.* Middletown, CT: Wesleyan University Press.

Van Der Schyff, D., Schiavio, A., Walton, A., Velardo, V., & Chemero, A. (2018). Musical creativity and the embodied mind: Exploring the possibilities of 4E cognition and dynamical systems theory. *Music & Science*, 1.

Unconscious intent in the creative process of composition

Jonathan Mortimer
Liverpool Hope University, Liverpool, United Kingdom

BACKGROUND

Does an introspective analysis of music composed by its own analyst give insight into the compositional act per se? Whilst analysis has always been used to give an insight into the composer's mind (e.g., Cook, 1987), Cook himself (1996), recommends using composition itself as a tool for analysis. This leads to an interesting question: can a composer gain insight into their own creative process by analysis of their own compositions? A small number of examples of the use of subjective personal introspection by composers have been found in the literature (e.g., Collins, 2005, 2012) but systematic examination has been limited.

This paper presents data from an introspective statistical analysis of a portfolio of the author's own compositions written over a five-year period and suggests that, at least in this case, there are unconscious intentions that guide a developing compositional process. Whilst at this stage, no claims are made for more general applicability, it is suggested that there is potential for a wider study across a body of composers.

Most traditional analysis focuses on notation rather than the listener experience. However, Huron (2006 and 2016) and others (e.g., Narmour, 1990) have found that listeners and performers of a musical work have a number of expectations as to how that work will progress that they unconsciously experience whilst listening. Whether these expectations are confirmed or violated has a significant effect on their response to the music. Many of these expectations are reactions in real time and have been found to be similar over a large corpus of genres of music.

This composer was intrigued as to whether the same phenomena affected the development of a composition. Does the composer, when creating a piece of music, have the same unconscious expectations as to how the music should proceed? After all, composers are themselves listeners and often performers of music, so would it be unlikely for them to have the same response to the music they create? To what extent do they deviate from this?

AIMS

The aim of this introspective analysis was to examine to what extent the author's compositional process might be governed or guided by unconscious intent and if so, to what extent this varied as compositional skill developed. Huron and others have found that listeners and performers of music are guided by expectational schema of melodic structure such as pitch proximity, pitch tendency, step inertia, post skip reversal and regression to the mean. They also found that musical interest was brought about by violations of these expectations that fit with the musical schema of the piece. Did this also coincide with the self-perceptions of the composer?

METHOD

A portfolio of compositions written over a five-year period for submission for a PhD by portfolio by the author had been notated computationally using Sibelius software. Scores and parts were exported to midi files and analysed using Music Processing Suite software developed by Hofmann (2018) for pitch proximity, pitch tendency, step inertia, post skip reversal and regression to the mean for each piece. Dissonance and harmonic intervals were also similarly examined. In addition, pitch class distribution for each piece was derived from plug-ins developed for Sibelius by Zawalich (2020).

RESULTS

Examination of melodic structure in terms of pitch proximity, pitch tendency, step inertia, post skip reversal and regression to the mean demonstrated that compositional development unconsciously followed the expectation theories of Huron (op cit.) for large passages over the entire portfolio. However, over time, as compositional skills increased, deviations from these became more significant and frequent. Harmonic expectations in terms of dissonance and pitch class distribution follow the same pattern.

Major points of interest in the pieces felt by the composer in developing the piece were often found to be manipulations of these melodic expectations by, for example, fragmentation, retrograding or inversion, violating them by inverting or subverting the unconscious predictive patterns.

DISCUSSION

Expectation theories derived from statistical analyses of a wide variety of compositions Huron (op cit.), show that certain inherent properties of music are expected unconsciously by listeners and performers of that culture. Composers, to the author's knowledge from an extended study of the literature, do not appear to have applied this same analysis to their own work to examine their own creative processes.

Expectation theories demonstrate that listeners expect a certain level of unconscious predictability in music to elicit a positive response to it but that a level of violation of these expectations is required to create sufficient surprise to create and maintain interest. This study of the author's own compositions shows that, for this composer at least, the same expectations of listeners and performers have been found in their compositional process. An interesting finding has been the development over time of patterns of violation that, once found,

appear to recur in subsequent pieces and become embedded in the author's practices. These become more developed and more frequent as time progresses. It is not known at this time whether this may be a more general phenomenon amongst developing composers in general, but the techniques discussed here demonstrate a potentially more widely applicable methodology to do so.

REFERENCES

Collins, D. (2005). A synthesis process model of creative thinking in music composition. *Psychology of Music, 33*(2): 193-216.

Collins, D. (Ed.). (2012). *The act of musical composition*. Farnham: Ashgate Publishing.

Cook, N. (1987). *A guide to musical analysis.* Oxford: Oxford University Press.

Cook, N. (1996). *Analysis through composition*. Oxford: Oxford University Press.

Hofmann, D. M. (2018). *Music processing suite: A software system for context-based symbolic music representation, visualization, transformation, analysis and generation.* Doctoral Dissertation. University of Music, Karlsruhe.

Huron, D. (2006). *Sweet anticipation: Music and the psychology of expectation*. Cambridge Massachusetts: MIT Press.

Huron, D. (2016). *Voice leading: The science behind a musical art*. Cambridge Massachusetts: MIT Press.

Narmour, E. (1990). *The analysis and cognition of basic melodic structures: The implication-realization model*. Chicago: University of Chicago Press.

Zawalich, R. (2018). *Sibelius plugin resources,* https://bobzawalich.com/sibelius/ Accessed 10th June 2022.

A methodological design for the study of expressive bodily movement in saxophone performance

Nádia Moura[1,2], João Paulo Vilas-Boas[3,4], Sofia Serra[1,2]

[1]Universidade Católica Portuguesa (UCP), Porto, Portugal.
[2]Research Centre for Science for Science and Technology of Arts (CITAR), Porto, Portugal.
[3]Centre of Research, Education, Innovation and Intervention in Sport, CIFI2D, Porto, Portugal.
[4]Porto Biomechanics Laboratory, LABIOMEP-UP, Porto, Portugal

BACKGROUND

Performative bodily movement has been studied in multiple contexts, from musicians' medicine to technical efficiency, expression, and communication. While the first two focus on closed, definite answers to their research questions, mostly achievable through quantitative measurement, the latter raises much more of a methodological discussion given its subjective nature. What kind of movement is considered expressive? How can movement convey information about music? Research underlines the importance of including different persons' perspectives on the subject, as well as combining qualitative and quantitative data (Leman, 2007, 2016; Schacher, 2015; Visi et al., 2020). Moreover, each musical instrument has biomechanical characteristics and a playing technique that influence the performer's bodily behaviour, advocating the need to adapt research procedures to these specificities.

AIMS

A methodological design was developed to study ancillary movements integrated in saxophone performance with the goal of extracting expressive gestural patterns. The aim of this project is to establish pedagogical guidelines for sax players on body awareness for facilitative and communicative purposes.

METHOD

Previous works addressing the blending of multimodal data in performance analysis were considered in the conception of the methodology (Lesaffre & Leman, 2020; Lourenço et al., 2014; Visi et al., 2020), divided in two ongoing phases: a) movement analysis of saxophonists and b) audience perception assessment. In phase a), a collection of audio, video and mocap data of 20 saxophonists playing 5 standard excerpts occurred, to which qualitative (systematic observation and coding) and quantitative (audio and mocap feature extraction) procedures of analysis are being applied. Interviews were also conducted to gather information on the performers' perceptions. In phase b), perceptual experiments comprising 3D performance representations of distinct motion patterns are being carried to evaluate how these influence audience's opinion (quality, expressiveness, professionalism of the performer) and auditory perception of dynamics and articulation.

RESULTS

Qualitative movement analysis resulted in the creation of a saxophone gesture vocabulary, considering previously identified types in other instruments (e.g., Davidson, 2012; Wanderley et al., 2005; Weiss et al., 2018), comprising 15 gesture types (head nod; shoulder elevation; flap; wrist elevation; trunk flexion; trunk lateral inclination; knee flexion; feet elevation; footstep; bell lift, circle and sweep; anteroposterior and mediolateral sway; full-body rotation). Thus, it allowed the identification of gestural trends amongst saxophonists in relation to the performed music, which were organised into the categories: expressive communication, pitch influence, rhythm and pulse influence, technique facilitation and general motion. Further developments include the complementary kinematic analysis of these patterns. In parallel, one perceptual experiment is taking place to understand which motion patterns translate as more meaningful to the audience in contrasting pieces of music.

DISCUSSION

The preliminary results of the application of this methodology seem to confirm the beneficial effects of adopting mixed methods on the study of musicians' expressive bodily motion. Additionally, the data collection design and marker setup revealed to be appropriate to saxophone players. The common interpretative behaviours of the participants may be translated as pedagogical guidelines towards musical expressive communication, after the planned analysis procedures are complete.

REFERENCES

Davidson, J. W. (2012). Bodily movement and facial actions in expressive musical performance by solo and duo instrumentalists: Two distinctive case studies. *Psychology of Music*, *40*(5), 595–633.

Leman, M. (2007). *Embodied music cognition and mediation technology*. The MIT Press.

Leman, M. (2016). *The expressive moment: How interaction (with music) shapes human empowerment*. MIT Press.

Lesaffre, M., & Leman, M. (2020). Integrative research in art and science: A framework for proactive humanities. *Critical Arts*, *34*(5), 39–54. https://doi.org/10.1080/02560046.2020.1788616

Lourenço, S., Martins, L. G., Tits, M., & Megre, R. (2014). Towards a multimodal analysis of European piano schools of music performance. In T. Klouche & E. R. Miranda (Eds.), *Proceedings of the 9th Conference*

on Interdisciplinary Musicology – CIM14. Berlin, Germany 2014 (pp. 191–194).

Schacher, J. C. (2015). Music means movement - Musings on methods for movement analysis in music. In S. Alaoui, P., Pasquier, T., Schiphorst, J. Françoise, & Bevilacqua F. (Eds.), *MOCO '15: Proceedings of the 2nd International Workshop on Movement and Computing, August 14 - 15 2015, Vancouver, Canada* (pp. 132–139). Association for Computing Machinery. https://doi.org/10.1145/2790994.2791001

Visi, F., Östersjö, S., Ek, R., & Röijezon, U. (2020). Method development for multimodal data corpus analysis of expressive instrumental music performance. *Frontiers in Psychology*, *11*(December).

Wanderley, M., Vines, B. W., Middleton, N., McKay, C., & Hatch, W. (2005). The musical significance of clarinetists' ancillary gestures: An exploration of the field. *Journal of New Music Research*, *34*(1), 97–113.

Weiss, A. E., Nusseck, M., & Spahn, C. (2018). Motion types of ancillary gestures in clarinet playing and their influence on the perception of musical performance. *Journal of New Music Research*, *47*(2), 129–142.

Employment of cognitive science theories to improve aural training through digital tools

David A. Munive Benites[1,2], Philippe Lalitte[1,2,3,4]

[1]Sorbonne University, Paris, France

[2]Institut de Recherche en Musicologie, Paris, France

[3]Haut Conseil de l'Évaluation de la Recherche et de l'Enseignement Supérieur, Paris, France

[4]Centre de Recherche et d'Expérimentation sur l'Acte Artistique, Strasbourg, France

BACKGROUND

The present study focuses on pedagogical software developed for aural education of western tonal music for adult students that takes explicitly into account the literature from music pedagogy and cognition. A large number of web, desktop and mobile applications target the development of aural skills (not including applications that focus on learning an instrument or reading music notation). There exists abundant literature on this topic in the domains of musicology, pedagogy, psychology, computer assisted learning and various aspects of neuroscience. However, most applications replicate old, highly criticised methods (using acontextual musical elements or mainly focusing on reproductive activities). Often these digital tools ignore many aspects of the research in aural skills acquisition (Karpinski, 2000; Klonoski, 2006), the role of evolutionary adaptive functions such as the Auditory Scene Analysis (or ASA, is the ability to parse complex acoustic information into coherent objects (Bregman, 1994)) and the influence of culture on the perception and creation of music (Honing et al., 2015; Mehr et al., 2019; Trainor, 2015). In addition, the scientific literature (Kilic, 2017; Savage, 2007), and a case study on a course of aural education at Sorbonne University reveal that the teachers do not considerably benefit from these kind of tools.

AIMS

The work currently presented aims to set the theoretical basis for formulating a pedagogical framework with a set of hypotheses that would optimize aural education with the help of a digital tool. Taking into account theories of music cognition and perception, some hypotheses for optimization of these learning applications are suggested based on ASA (Bregman, 1994; McAdams, 2019; McLachlan, 2011), executive functions (Brandler & Rammsayer, 2003; Chan et al., 2008; Strait et al., 2010) and musical imagery (Gates, 2021; Herholz et al., 2008; Keller, 2012).

METHOD

The state of the art concerning software for music learning is assessed through a literature review and the evaluation of available options to the general public. Following, the relationship between theories of aural perception, ASA, mental imagery and executive functions is analysed. This evaluation leads to the development of a pedagogical framework based on these theories to be presented through a software.

RESULTS

The analysis of processes involved in music cognition as well as suggestions to aural education suggest that specific work targeting aspects of ASA would be potentially beneficial. An example using auditory stream segregation based on priming is described. This framework proposes alternative training and evaluation methods for aural training. The benefits of implementing this pedagogical framework in software are the lack of temporal or spatial constraints for practice, instant feedback, and possible gamification (according to usability metrics and multimedia learning theories).

DISCUSSION

Aspects of perceptive problems identified by the theory of ASA (like simultaneous grouping, sequential grouping and stream segregation) could potentially be better targeted through aural learning software. The improvement of executive functions (working memory, flexible thinking, and self-control) and the specific practice of music imagery could be integrated in the process of aural education. Practice of these skills could have implications for other aspects of music learning. This framework produces guidelines for the creation of a pedagogical digital tool that targets specific aspects of the ASA, takes into account the evolution of musical imagery, and in the process encourages the development of executive functions. Additionally, the implementation of this pedagogical framework could reveal details about the relationship between ASA and aural skills acquisition.

REFERENCES

Brandler, S., & Rammsayer, T. H. (2003). Differences in mental abilities between musicians and non-musicians. *Psychology of Music, 31*(2), 123–138. https://doi.org/10.1177/0305735603031002290

Bregman, A. S. (1994). *Auditory scene analysis: The perceptual organization of sound*. MIT Press.

Chan, R. C. K., Shum, D., Toulopoulou, T., & Chen, E. Y. H. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology, 23*(2), 201–216.

Gates, S. (2021). Developing musical imagery: Contributions from pedagogy and cognitive science. *Music Theory Online, 27*(2). https://mtosmt.org/issues/mto.21.27.2/mto.21.27.2.gates.html

Herholz, S. C., Lappe, C., Knief, A., & Pantev, C. (2008). Neural basis of music imagery and the effect of musical expertise. *European Journal of Neuroscience, 28*(11), 2352–2360.

Honing, H., ten Cate, C., Peretz, I., & Trehub, S. E. (2015). Without it no music: Cognition, biology and evolution of musicality. *Philosophical Transactions of the Royal Society B: Biological Sciences, 370*(1664), 20140088.

Karpinski, G. S. (2000). *Aural skills acquisition: The development of listening, reading, and performing skills in college-level musicians*. Oxford University Press.

Keller, P. E. (2012). Mental imagery in music performance: Underlying mechanisms and potential benefits. *Annals of the New York Academy of Sciences, 1252*(1), 206–213.

Kilic, D. B. Ç. (2017). Examining music teachers' self-confidence level in using information and communication technologies for education based on measurable variables. *Educational Research and Reviews, 12*(3), 101–107.

Klonoski, E. (2006). Improving dictation as an aural-skills instructional tool. *Music Educators Journal, 93*(1), 54–59.

McAdams, S. (2019). Timbre as a structuring force in music. In K. Siedenburg, C. Saitis, S. McAdams, A. N. Popper, & R. R. Fay (Eds.), *Timbre: Acoustics, perception, and cognition* (pp. 211–243). Springer International Publishing. https://doi.org/10.1007/978-3-030-14832-4_8

McLachlan, N. (2011). A neurocognitive model of recognition and pitch segregation. *The Journal of the Acoustical Society of America, 130*(5), 2845–2854. https://doi.org/10.1121/1.3643082

Mehr, S. A., Singh, M., Knox, D., Ketter, D. M., Pickens-Jones, D., Atwood, S., … Glowacki, L. (2019). Universality and diversity in human song. *Science, 366*(6468), eaax0868. https://doi.org/10.1126/science.aax0868

Savage, J. (2007). Reconstructing music education through ICT. *Research in Education, 78*(1), 65–77.

Strait, D. L., Kraus, N., Parbery-Clark, A., & Ashley, R. (2010). Musical experience shapes top-down auditory mechanisms: Evidence from masking and auditory attention performance. *Hearing Research, 261*(1), 22–29.

Trainor, L. J. (2015). The origins of music in auditory scene analysis and the roles of evolution and culture in musical creation. *Philosophical Transactions of the Royal Society B: Biological Sciences, 370*(1664), 20140089.

Singing in the mind: Musicians' respiratory organization during vocal imagery

Anna M. Niemand[1], Sara D'Amario[1], Werner Goebl[1], Laura E. Bishop[2]
[1]Department of Music Acoustics – Wiener Klangstil; University of Music and Performing Arts Vienna, Vienna, Austria.
[2]RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Oslo, Norway

BACKGROUND

The cognitive representation of sound (auditory imagery) and vocal sound production
have been widely investigated in the field of speech and music performance research. Some papers focus on the bodily reactions that emerge while imagery tasks are carried out in a musical context, and relate these reactions to frameworks that describe music making as an embodied process (van der Schyff et al., 2018). Muscle activation (Pruitt et al., 2019) and motion processing (Keller et al., 2010; Aleman & Wout, 2004) have been shown to be related to covert representation of sound production. Cognitive processes like attention, cognitive workload (Van Diest et al., 2006; Vlemincx et al., 2011) and vocal strategies (Sakaguchi & Aiba, 2016) influence respiration. However, it remains unclear how musicians organise their respiration while imagining singing and whether respiration during imagery is similar to respiration during overt singing.

AIMS

This research investigates the effects of vocal imagery – auditory imagery with a vocal strategy – on the respiratory behaviour of trained musicians.

METHODS

Thirty-two musicians (16 instrumentalists and 16 singers) performed three different tasks while their respiration was measured as the combined relative circumference of the thorax and abdomen. Participants either listened to, imagined singing, or overtly sang a set of different melodies. Musical notation of the melodies was displayed on a screen in front of the participants and recordings of the melodies with a MIDI generated oboe sound were played once prior to the start of each trial.

RESULTS

The analysis is underway. Respiration signals for the different melodies will be compared within-subjects across conditions (i.e., listening, imagining to sing, and singing). Cross-correlation analysis will be used to assess the degree of respiratory consistency between 1) singing and listening and 2) singing and vocal imagery. The effects of task will be evaluated using linear mixed effects models. We hypothesise that musicians breathe more similarly in singing and vocal imagery than in singing and passive listening.

DISCUSSION

This study is expected to show that respiratory organisation in the vocal imagery tasks is more consistent with respiration in actual singing than respiration in passive listening. Findings should indicate the influence of an inner cognitive representation of music on respiration, emphasizing the active and embodied nature of musical imagery, and show how central cognitive processes manifest at a peripheral physiological level.

REFERENCES

Aleman, A. & Wout, M. v. (2004). Subvocalization in auditory-verbal imagery: just a form of motor imagery?. *Cognitive Processing* 5(4), 228–231.

Keller, P. E., Dalla Bella, S., & Koch, I. (2010). Auditory imagery shapes movement timing and kinematics: Evidence from a musical task. *Journal of Experimental Psychology: Human Perception and Performance* 36(2).

Pruitt, T. A., Halpern, A. R., & Pfordresher, P. Q. (2019). Covert singing in anticipatory auditory imagery. *Psychophysiology* 56(3), e13297.

Sakaguchi, Y. & Aiba, E. (2016). Relationship between musical characteristics and temporal breathing pattern in piano performance. *Frontiers in Human Neuroscience*, 10.

van der Schyff, D., Schiavio, A., Walton, A., Velardo, V., & Chemero, A. (2018). Musical creativity and the embodied mind: Exploring the possibilities of 4E cognition and dynamical systems theory. *Music & Science,* 1.

Van Diest, I., Thayer, J. F., Vandeputte, B., Van de Woestijne, K. P., & Van den Bergh, O. (2006). Anxiety and respiratory variability. *Physiology & Behavior* 89(2), 189–195.

Vlemincx, E., Taelman, J., Peuter, S. D., Diest, I. V., & Bergh, O. V. D. (2011). Sigh rate and respiratory variability during mental load and sustained attention. *Psychophysiology* 48(1), 117–120.

Study of involuntary musical imagery (INMI) experiences in everyday life*

Joon Oh

Queen Margaret University, Edinburgh, United Kingdom

BACKGROUND

Understanding spontaneous cognitions that constitute a large part of our daily mental activity in our lives provides meaningful insight into exploring aspects of human cognition that have not yet been revealed. Involuntary Musical Imagery (INMI) is a spontaneous musical experience usually referred to as an 'earworm', which refers to the phenomenon that music comes to mind and repeats without conscious control (Beaman & Williams, 2010). The occurrence of INMI is not a low-level cognitive response caused by a simple external stimulus, but a complex process mediated by various environmental, musical, and personal characteristics and issues (Floridou & Müllensiefen, 2015; Jakubowski et al., 2018; Liikkanen, 2012; Williamson et al., 2012). Various dimensions and elements of INMI have recently been identified and these studies have raised the possibility of associations between the elements that make up the INMI experience and cognitive domains such as emotions, memories, and specific behaviour patterns.

AIMS

The purpose of this study is to identify and categorise the factors that trigger an individual's INMI experiences in natural daily life and to investigate the relationship between INMI triggers, personal characteristics, and affective states induced by INMI.

METHODS

To explore the daily INMI experience, the self-report diary method was used (Jakubowski, et al., 2015). Participants accessed the online diary form to report information related to the occurrence and situation of their INMI experience. In addition, participants were asked to rate how the INMI tune had affected their level of emotional arousal, valence, and changes in mood states.

RESULTS

A total of 103 INMI diary sheets were collected from 21 participants who completed the initial survey and completed the diary. Triggers were grouped through thematic analysis, and the results showed that they were classified into 5 categories: Recent/repeated exposure, Situational stimulus, Memory/thinking, Preference, and No idea. In addition, affective states measured through emotional valence and arousal rating showed significant differences depending on the INMI trigger group.

Although the number of INMIs reported by participants was not significantly correlated with their scores on the general musical sophistication index (Müllensiefen et al., 2011), there was a significant positive correlation between musical sophistication scores and emotional valence ratings. Along with this, the result of examining the consistency of the trigger for individual participants indicated the possibility that the dominant trigger factor may exist depending on the individual although various triggers contribute to the beginning of the INMI experience.

DISCUSSION

The result provides insight into what elements fundamentally influence the INMI experience is in the sense that it explored the potential relationship between INMI triggers and other affective and personal factors. Specifically, it suggests that cognitive factors involved in the initiation of INMI can have a significant influence on emotional responses induced by INMI. This can provide meaningful implications for how the cognitive and unconscious elements of the experience are related to each other.

This study is a part of the MSc research project at Goldsmiths, University of London.

REFERENCES

Beaman, C. P., & Williams, T. I. (2010). Earworms (stuck song syndrome): Towards a natural history of intrusive thoughts. *British Journal of Psychology*, 101(4), 637-653.

Floridou, G. A., & Müllensiefen, D. (2015). Environmental and mental conditions predicting the experience of involuntary musical imagery: An experience sampling method study. *Consciousness and Cognition*, 33, 472-486.

Jakubowski, K., Farrugia, N., Halpern, A. R., Sankarpandi, S. K., & Stewart, L. (2015). The speed of our mental soundtracks: Tracking the tempo of involuntary musical imagery in everyday life. *Memory & Cognition*, 43(8), 1229-1242.

Jakubowski, K., Bashir, Z., Farrugia, N., & Stewart, L. (2018). Involuntary and voluntary recall of musical memories: A comparison of temporal accuracy and emotional responses. *Memory & Cognition*, 46(5), 741-756.

Liikkanen, L. A. (2012). Musical activities predispose to involuntary musical imagery. *Psychology of Music*, 40(2), 236-256.

Müllensiefen, D., Gingras, B., Stewart, L., & Musil, J. (2011). The Goldsmiths Musical Sophistication Index (Gold-MSI): Technical Report and Documentation v0. 9. London: Goldsmiths, University of London.

Williamson, V. J., Jilka, S. R., Fry, J., Finkel, S., Müllensiefen, D., & Stewart, L. (2012). How do "earworms" start? Classifying the everyday circumstances of Involuntary Musical Imagery. *Psychology of Music*, 40(3), 259-284.

The use of meditation as a tool to counteract music performance anxiety from the perspective of psychologists and performance coaches

Serena Paese[1], Hauke Egermann[1,2]

[1]University of York, York, United Kingdom.

[2]Institut für Musik und Musikwissenschaft, Technische Universität Dortmund, Dortmund, Germany

BACKGROUND

Music performance anxiety (MPA) affects numerous musicians, preventing them from performing to the full extent of their abilities (Kenny, 2011; Steptoe & Fidler, 1987). A variety of tools are used to cope with the multifaceted symptomatology of MPA, and in recent decades, meditation has become a popular approach and object of interest for researchers (Butzer et al., 2016; Czajkowski et al., 2020; Lin et al., 2008). Although a distinction is partially made between the types of meditative techniques and their effects on MPA, this aspect is still not thoroughly investigated.

AIMS

The aim of this qualitative study is to investigate the experience of specialists who include meditation as a tool to counteract MPA in their coaching or psychological work.

METHOD

Semi-structured interviews with psychologists and performance coaches ($N = 19$) were held online over 12 months; recordings and transcripts were verified multiple times. The documents were subsequently imported into the Nvivo software, and a thematic analysis was conducted with bottom-up approach. The classification system proposed by Matko and Sedlmeier (2019) was used to allocate the different meditative techniques into a range of sub-themes.

RESULTS

The themes developed illustrate how the experts describe MPA, the influencing factors for the effectiveness of meditation, the meditation techniques suggested by experts to counteract MPA. Within the last theme, body-centred meditations are reported to be effective in counteracting physiological symptoms because they act on body perception and awareness. Breathing techniques are frequently used with a daily practice as well as in backstage moments to operate on physiological and cognitive aspects. Mindful observation meditations correlate with the ability to observe without action and judgement which is considered to have an optimal effect on the entire MPA symptomatology. Results show furthermore that affect-centered meditations offer interesting perspectives for counteracting perfectionism and self-criticism that have been described as crucial components in the onset of MPA. The correlation between the types of symptoms and the types of meditative techniques was developed according to the specialists' experience.

DISCUSSION

This interview study investigated the specialists' lived experience in using meditation as a tool to cope with MPA in coaching or psychological work with musicians. The core of the study is the recognition of the techniques mostly applied to MPA, with a correlation between symptoms and meditation techniques. However, the complexity of the symptomatology of MPA (Kenny, 2011; Lehmann et al., 2007) implies a combined use of several techniques, as the experts reported in the interviews. The study results confirm the outcomes of previous research on the effects of meditation on MPA (Butzer et al., 2016; Czajkowski et al., 2020; Lin et al., 2008). To further investigate the correlation between MPA symptoms and meditation techniques, future exploratory research is desirable to highlight the effects of the techniques in detail, as in previous research conducted in the extra-musical domain (Singer & Engert, 2019). This research outcomes may be of interest to musicians who want to acquire emotional awareness and self-regulation strategies for counteracting MPA and improving performance skills, and to educational institutions.

REFERENCES

Butzer, B., Ahmed, K., & Khalsa, S.B.S. (2016). Yoga enhances positive psychological states in young adult musicians. *Applied Psychophysiological Biofeedback, 41*(2), 191-202.

Czajkowski, A. L., Greasley, A. E., & Allis, M. (2020). Mindfulness for musicians: A mixed methods study investigating the effects of 8-week mindfulness courses on music students at a leading conservatoire. *Musicae Scientiae, 00*(0), 1-21. https://doi-org/10.1177%2F1029864920941570

Kenny, D. (2011). *The psychology of music performance anxiety*. Oxford University.

Lehmann, A., Sloboda, J. A., & Woody, R. M. (2007). *Psychology for musicians. Understanding and acquiring the skills*. Oxford University Press.

Lin, P., Chang, J., Zemon, V., & Midlarsky, E. (2008). Silent illumination: A study on Chan (Zen) meditation, anxiety, and musical performance quality. *Psychology of Music, 36*(2), 139-155.

Matko, K. & Sedlmeier, P. (2019). What is meditation? Proposing an empirically derived classification system. *Frontiers in Psychology, 10*, 2276, 1-14. https://doi.org/10.3389/fpsyg.2019.02276

Singer, T., & Engert, V. (2019). It matters what you practice: differential training effects on subjective experience, behaviour, brain and body in the ReSource Project. *Current Opinion in Psychology, 28*, 151-158.

Steptoe, A., & Fidler, H (1987). Stage fright in orchestral musicians: A study of cognitive and behavioural strategies in performance anxiety. *British Journal of Psychology, 78*, 241-49.

Review of machine learning techniques applied to influence behavior while listening to music

Brayan Rodríguez[1], Felipe Reinoso-Carvalho[2], Javier Díaz-Cely[3,4]

[1]School of Engineering, Universidad de los Andes, Bogotá, Colombia.

[2]School of Management, Universidad de los Andes, Bogotá, Colombia.

[3]Department of Information and Communication Technologies, Universidad Icesi, Cali, Colombia.

[4]MO Tecnologías, Bogotá, Colombia

BACKGROUND

A comprehensive review on machine learning techniques employed to model and process music data seems to be missing in the recent literature, despite their exponential recent growth in the field of music information retrieval. To our knowledge, one broad review covering the machine learning techniques used to process music features considering effects on listeners was reported back in 2012 (Kaminskas & Ricci, 2012). Since then, reviews have focused on only single applications of music modelling, such as music recommendation (Bonnin & Jannach, 2014; Schedl, 2019), classification (Chaudhary et al., 2020), or generation (Carnovalini & Rodà, 2020).

AIMS

In this work in progress, we aim to explore all types of machine learning techniques being used in this field, regardless of the application involved. We wanted to study how machine learning techniques have been applied to represent music listener profiles and influence their behaviour.

METHOD

Following the Kitchenham guidelines (Kitchenham et al., 2007) in the planning and conducting stages of performing a systematic literature review, as a starting point, we found important preliminary insights while analysing a first subset of papers. In particular, we reported 46 scientific articles on applications of machine learning techniques employed to classify, generate, or analyse music features that might affect behaviour in particular ways. The proposed methodology focused on characterizing these articles throughout the following dimensions: machine learning task/technique, music representations (acoustical, musicological, meta-tags), listener profile representations, measurements of effects on behaviour, origin of music dataset, and main task of the research.

RESULTS

The surveyed studies were found to principally adopt one of three major methodology workflows (group 1 - music dataset, group 2 - user-music interaction trace, group 3 - real users in training dataset). In the first group, five studies focused on music datasets, which only considered the music representations to feed the learning algorithms, without any user-music interaction data. In the second group, which involved most of these studies (30), the user-music interaction trace from existing datasets was gathered, but without involving the interaction collection process. In the third group, eleven studies took into account the user-fed training dataset obtained by an intermediary device, which collected the corresponding user-music interaction.

Concerning the machine learning process, the general analysis also revealed that latent representations, which are typically used in high-dimensional data contexts - such as music data representations - were the most frequently applied. Importantly, such analysis also pointed towards deep learning techniques (i.e., neural networks) as being increasingly applied in the most recent studies.

DISCUSSION

Based on the analysis of this first subset of papers, the obtained results show that machine learning techniques can be applied to effectively perform tasks to influence the behaviour of listeners, going beyond the listener profile preferences (i.e., musical queries, music mood classification, music recommendation/generation, music tagging). Thus, based on such promising preliminary data, we aim to continue analysing a wider set of papers according to the aforementioned systematic literature review methodology, to holistically approach some of the major challenges in the field of music listener representation.

REFERENCES

Bonnin, G., & Jannach, D. (2014). Automated generation of music playlists: Survey and experiments. *ACM Computing Surveys, 47*(2), 1–35. https://doi.org/10.1145/2652481

Carnovalini, F., & Rodà, A. (2020). Computational creativity and music generation systems: An introduction to the state of the art. *Frontiers in Artificial Intelligence, 3*, 14.

Chaudhary, D., Singh, N. P., & Singh, S. (2020). A survey on autonomous techniques for music classification based on human emotions recognition. *International Journal of Computing and Digital Systems, 9*(3), 433–447.

Kaminskas, M., & Ricci, F. (2012). Contextual music information retrieval and recommendation: State of the art and challenges. *Computer Science Review, 6*(2–3), 89–119.

Kitchenham, B., Kitchenham, B., & Charters, S. (2007). *Guidelines for performing systematic literature reviews in software engineering.* http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.117.471

Schedl, M. (2019). Deep learning in music recommendation systems. *Frontiers in Applied Mathematics and Statistics, 5*, 44. https://doi.org/10.3389/FAMS.2019.00044/BIBTEX

A survey into piano teachers' perceptions of music memorization methods in one-to-one piano lessons

Chara Steliou, Kelly Jakubowski

Durham University, Durham, United Kingdom

BACKGROUND

Despite the standard expectation of audiences and many competitions/auditions committees that performers should be able to perform extensive musical works from memory, there is a dearth of systematic research on music memorization pedagogy, and a lack of consensus amongst music teachers on the most effective methods of teaching music memorization. Music psychologists have examined such topics as performance cues, mental practice, and expert memory (Chaffin et al., 2016, 2009; Bernardi et al., 2013; Mishra, 2017). Such research has primarily focused on strategies used by expert performers and university students, with limited insights on how memorization is taught to beginner/intermediate students.

AIMS

This study aims to investigate the extent to which music memorization is taught to children and adolescents in one-to-one piano lessons and to explore the diversity of strategies used for teaching memorization.

METHOD

Participants were provided with an online questionnaire comprising 44 items in total, including demographic questions, rating scales probing different types of memorization strategies, and open-ended questions. The questionnaire was completed by piano teachers who teach beginner/intermediate level students under the age of 18 at private schools and music schools. The primary focus of this study is on 3 of the open-ended questions: 1) Give a brief description of music memorization, 2) How would you teach memorization in Kabalevsky's Galop? (a beginner piano piece that participants were provided with) 3) How do you memorize as a performer? Participants were recruited via online advertisements and international schools in the UAE. In total 70 participants completed the survey, however only the data of 37 participants who completed 75% or more were used in this study. These 37 participants had a mean age of 43.65 years (range = 25-81, SD = 12.74), 32 females and 5 males.

RESULTS

Results indicate that music memorisation is perceived by the participants as a skill that develops through practice rather than a natural talent. Reported strategies for teaching memorisation fell into four categories: aural, visual, kinaesthetic, and analytical, which aligns with previous theoretical conceptualisations of musical memorisation. Recurring mentions of muscle memory/repetition practice and music theory knowledge suggest that kinaesthetic and analytical memorisation methods are dominant when teaching music memorisation to children learning the piano. In particular, thematic analysis across all the three qualitative questions shows that kinaesthetic and analytical memorisation methods were dominant when compared to aural and visual which received a smaller number of responses.

DISCUSSION

Previous theoretical conceptualisations of music memorisation on aural, visual, kinaesthetic and analytical methods align with the current study which suggests that these four memorisation methods are used when teaching memorisation on piano students under the age of 18. However, kinaesthetic and analytical methods were qualitative dominant in the way 1) a teacher defines music memorisation, 2) memorizes as a performer and 3) teaches memorisation as a teacher. This suggests that aural and visual memorisation abilities of students under the age of 18 might be less explored while learning and performing from memory, and that future research could be conducted to develop a more well-rounded approach.

REFERENCES

Bernardi, N. F., Schories, A., Jabusch, H. C., Colombo, B., & Altenmüller, E. (2013). Mental practice in music memorization: An ecological-empirical study. *Music Perception*, 30, 275–290.

Chaffin, R., Lisboa, T., Logan, T.R, & Begosh, K. T. (2009). Preparing for memorized cello performance: the role of performance cues. *Psychology of Music*, 38(1), pp.3- 30.

Chaffin, R., Demos, A. P., & Logan, T. (2016). Performing from memory. In S. Hallam, I. Cross, & M. Thaut (Eds.), Oxford library of psychology. *The Oxford handbook of music psychology* (p. 559–571). Oxford University Press.

Mishra, J. (2007). Correlating musical memorization styles and perceptual learning modalities. *Visions of Research in Music Education*, 9(1), 1–19.

Metaphors in emotions between (Baroque and Galant) styles, aesthetics of rhymes: studying and connoisseuring rhyming in Italian, English and German in Handel´s opera Giulio Cesare

Marjo R. Suominen

University of Helsinki, Department of Philosophy, History, Culture and Art Studies, Institute of Musicology, Helsinki, Finland

BACKGROUND

Handel´s musical expression was largely going towards lighter style Galant, not totally against the traditional beginning of the 18th Century Baroque music making, but rather furthering it into some fresher musical fields by connecting tastefully Western European (here seen via German, Italian, French, and English music rhetoric) styles. This is reflected for instance in Handel´s opera Giulio Cesare´s dancelike catchy arias, which are set in da capo model as tripartite, meant to engage the listener-auditor´s moral sense and mind.

AIMS

This study aims at studying Handel´s opera Giulio Cesare and its performance instances via methods of historical-philosophical-aesthetic-deductive musical analysis and musical rhetoric/affects analysis to find an "ideal listener-auditor" of the work, which the composer might had in his mind while composing the opera. This is for gaining further knowledge of emotional tools impacting the listener-auditor via meaningful words emphasized elaborately endings with corresponding sounds in the opera.

METHOD

I utilize historical-philosophical-aesthetic-deductive musical analysis and musical rhetoric/affects analysis; Johann Mattheson´s musical affects theoretizations (1713 & 1739), Aristotle´s four elements (384-322BCE), and Plato´s atomism (429-347BCE) theories and can be described by Greimassian and Tarastian semiotic modal models (1992/2012).

RESULTS

The musical rhetorical symmetry in the opera is obvious. The first section of each aria is repeated decoratively in the end of the aria by the soloist, the middle sections of the arias are varying and contrasting by their textures, rhythms, musical keys, and moods, so that the listener´s attention is caught via elaborate emotional contents of the texts, seeking personal emotions and sensitivity, and impact on moral thinking, aiming for increasing empathetic and ethical ideas in the listener-auditors minds. Accordingly, the message is furthered via an emotion encouraged to be reflected via textual poetical verse. The meaningful words are being emphasized elaborately by endings with corresponding sounds.

DISCUSSION

Regardless of the language (or styles) utilized in the opera´s performance, the basic meaning remains in the intermediary duality between the main themes, the affects of love and revenge which are set as a bipartite counterforcible / reactional embodiment created by the characters of the opera. In the course of the work there is a balance maintained within the peace-love and revenge-hatred square (or Tarastian semiotic z-model) accel by emphasizing the opposites and the dramatic narrative and performative form between them. What are the means to find and influence on the listener-auditor within the musical work and its performances? How is the message of peace included in Handel´s musical working in the opera? How and by which accurate historical methods can we deduce the "true" aesthetic-rhetoric-emotional ideas of the "ideal listener-auditor" hidden in the opera by Handel and his librettist Haym and (in order to) understand them from today´s views?

Effective practice and performance preparation interventions for tertiary music students: a systematic review

Akiho Suzuki

Royal Northern College of Music, Manchester, United Kingdom

BACKGROUND

Tertiary music students spend a tremendous amount of time on individual practice to hone their skills and prepare for performances (Macnamara & Maitra, 2019). However, many students do not know how to use this time effectively as the skills required for effective practice are often not taught explicitly (Concina, 2019; Koopman et al., 2007). Over the recent years, studies have reported interventions that have aimed to equip students with the skills necessary for effective practice (e.g., Clark & Williamon, 2011; Hatfield, 2016). While systematic reviews of studies on music practice (How et al., 2021) and other interventions for musicians (e.g., performance anxiety; Burin & Osório, 2016) have been conducted, no systematic reviews of interventions for effective practice have been conducted to date. Such a review is necessary to identify current recommendations for practice and the limitations of interventions to date, and potentially lead to better support being made available for musicians.

AIMS

This study was a systematic review of interventions that aimed to help tertiary music students practise more effectively. Through this review, the study sought to determine the types of interventions that have been conducted, their effects, and their strengths and limitations.

METHOD

This review was carried out using the guidelines set out by Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). Several databases and key peer-reviewed journals were searched, as well as the reference list of How et al. (2021). After title/abstract and full-text screening, 30 studies were identified for inclusion. Upon initial coding of studies, it appeared that the identified studies could be categorized into two distinct types: *one-off experiments* that tested the effect of a specific strategy (e.g., mental practice), and *multicomponent interventions* that delivered a more comprehensive program. This study reports findings based on the multicomponent interventions. Twelve publications, each reporting one study, were included in the final analysis after backward and forward citation searches.

RESULTS

Of the 12 studies included, six studies implemented psychological skills training, while six studies targeted effective practice through an intervention based on self-regulated learning (Zimmerman, 2000). Frequently reported outcome measures included participant experience and practice quality. Some studies also reported performance quality, mental skills, self-efficacy, and performance anxiety. Reviewed interventions generally reported positive outcomes but often lacked control groups, used unvalidated scales, and did not provide detailed descriptions of intervention content.

DISCUSSION

Recommendations for future interventions are made based on findings. Studies reporting interventions should aim to provide detailed description about the intervention content and development process. This will allow for interventions to be replicated, which is not only important for research but also for persons who may want to implement research-based interventions for students. Studies should also aim to employ rigorous study design with validated measures to allow for meta-analyses to be undertaken in the future. Finally, researchers must start to explore ways to make interventions more widely available.

REFERENCES

Burin, A. B., & Osório, F. D. L. (2016). Interventions for music performance anxiety: Results from a systematic literature review. *Archives of Clinical Psychiatry (São Paulo)*, *43*(5), 116–131.

Clark, T., & Williamon, A. (2011). Evaluation of a mental skills training program from musicians. *Journal of Applied Sport Psychology*, *23*(3), 342–359. https://doi.org/10.1080/10413200.2011.574676

Concina, E. (2019). The role of metacognitive skills in music learning and performing: Theoretical features and educational implications. *Frontiers in Psychology*, *10*, 1583. https://doi.org/10.3389/fpsyg.2019.01583

Hatfield, J. L. (2016). Performing at the top of one's musical game. *Frontiers in Psychology*, *7*, 1356.

How, E. R., Tan, L., & Miksza, P. (2021). A PRISMA Review of Research on Music Practice. *Musicae Scientiae*, Advance Online Publication.

Koopman, C., Smit, N., de Vugt, A., Deneer, P., & den Ouden, J. (2007). Focus on practice-relationships between lessons on the primary instrument and individual practice in conservatoire education. *Music Education Research*, *9*(3), 373–397. https://doi.org/10.1080/14613800701587738

Macnamara, B. N., & Maitra, M. (2019). The role of deliberate practice in expert performance: Revisiting Ericsson, Krampe & Tesch-Römer (1993). *Royal Society Open Science*, *6*(8), 190327.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & for the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*, *339*, b2535.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press.

Statistical computation applied in music psychology: Understanding how music generates emotions

Florentina C. Ulmeanu Enea[1,2,3,4], Michael C. Barton[1]

[1]Arizona State University, Tempe, USA.

[2]University of Geneva, Geneva, Switzerland.

[3]University of Bucharest, Bucharest, Romania.

[4]West University of Timișoara, Timișoara, Romania

BACKGROUND

Historically, the relation of music and emotions has either been investigated using music as a holistic experience or without discriminating between instrumental music and programmatic music with lyrics. The call for a more fine-grained analysis focusing on musical cues, both structural and expressive, and music-related emotions has been emphasised by recent research in music psychology (Warrenburg, 2021). Moreover, the lack of statistically reproducible data is generating a schism in both musicologists and philosophers tackling the question, "How does music arouse emotions?" (Goldman, 1995), resulting in two main schools of thought: emotivism, which suggests that music feels a certain way by virtue of arousing that emotion in listeners (Carroll, 2003), and formalism, which proposes that instrumental music itself possesses expressive features (Kivy, 2006).

AIMS

This study addresses this issue by focusing, for the first time, on quantitative relationships between six musical features (four structural and two expressive), and nine music-related emotions.

METHOD

A set of 19 musical pieces were chosen as stimuli based on existing empirical studies which used them for their investigations (Vuoskoski et al., 2022; Zentner et al., 2008). Musical parameters for statistical analysis were selected after a thorough search of the available literature, including what is considered the most up-to-date and comprehensive study on this topic (Micallef Grimaud & Eerola, 2021). These are tempo, articulation, pitch, mode, dynamics, and brightness. Tempo was measured using a metronome and brightness using Audacity. For articulation, pitch, mode, and dynamics a set of rank-ordered scores were developed (ex. for articulation: 1 for staccato, 2 for detaché, and 3 for legato). Statistical analyses were performed in the widely used data science software R to identify potential covariance between these musical parameters and music-related emotions (wonder, transcendence, tenderness, nostalgia, peacefulness, sadness, energy, and joyful activation).

RESULTS

Multiple Linear Regression Analysis indicates that tenderness, peacefulness, and nostalgia are negatively correlated to brightness, whereas energy is positively correlated. Pitch is positively correlated to nostalgia and sadness and negatively correlated to energy. Dynamics is negatively correlated to tension and positively correlated to sadness. Mode has a little effect on sadness. Moreover, Principal Component Analysis showed that 76% of the variation of musical cues can be explained by three Principal Components dominated by articulation (PC1), dynamics (PC2), and brightness (PC3). Additionally, the most predictive contributors in Forward Stepwise Regression are tempo and brightness for tenderness, nostalgia, peacefulness and tension, pitch for sadness, energy, and joy and articulation for tenderness, joy, and peacefulness. Further Covariance Analysis indicates a minimal to modest effect between the investigated musical cues.

DISCUSSION

These results indicate that in assessing the method by which music influences emotions, at a group level, both structural (tempo, pitch) and expressive parameters (brightness) are important. Also, covariance analysis suggests that they act on human emotions in additive mode rather than in an interactive fashion. Moreover, some musical cues are more significant for emotion generation, such as tempo and brightness, whereas others show little effect (articulation). This preliminary study demonstrates the potential for quantitative analyses of musical cues to offer new and valuable insights into the ways in which different musical compositions affect emotional states. Further research of this nature is called for, as well as examining additional social and cultural factors that could impact the relationships between music and emotions.

REFERENCES

Carroll, N. (2003). Art and mood: Preliminary notes and conjectures. *The Monist, 86*(4), 521-555.

Goldman, A. (1995). Emotions in music (a postscript). *Journal of Aesthetics and Art Criticism, 53*(1), 59-69.

Kivy, P. (2006). Mood and music: Some reflections for Noël Carroll. *Journal of Aesthetics and Art Criticism*, *64*(2) 271-281.

Micallef Grimaud, A., & Eerola, T. (2021). EmoteControl: An interactive system for real-time control of emotional expression in music. *Personal and Ubiquitous Computing, 25*.

Vuoskoski, J. K., Zickfeld, J. H., Alluri, V., Moorthigari, V., & Seibt, B. (2022). Feeling moved by music: Investigating continuous ratings and acoustic correlates. *PLoS One, 17*(1), e0261151.

Warrenburg, L. (2021). The PUMS database: A corpus of previously-used musical stimuli in 306 studies of music and emotion. *Empirical Musicology Review, 16*(1), 145-150.

Zentner, M., Grandjean, D., & Scherer, K. (2008). Emotions evoked by the sound of music: Characterization, classification, and measurement. *Emotion, 8*, 494-521. https://doi.org/10.1037/1528-3542.8.4.494

Culture and ideal affect: Cultural dimensions predict Spotify listening patterns

Dianna Vidas, Lewis Nitschinsk, H. T. McGovern

The University of Queensland, Brisbane, Australia

BACKGROUND

Ideal affect describes the affective states individuals strive toward. Generally, people pursue a positively valenced state, but how they achieve this is largely driven by cultural differences, which are likely learned. These ideal affective states tend to differ across cultures - those from East Asia typically pursue low-arousal positive affect, while Latin American and Western European individuals typically pursue high-arousal positive affect. Previous research shows that music may be an effective way to regulate affective state; however, this is seldom examined through the lens of cultural differences. Furthermore, the relationships between the valence and arousal of music preferences and specific cultural dimensions remains underexplored.

AIMS

This study aimed to determine whether cultural variation in ideal affect is reflected in musical preferences on Spotify. Spotify aggregates weekly charts of countries' most popular songs, along with providing data of each song's valence and energy (arousal). Consistent with previous research with these cultures, we hypothesised that East-Asian Countries would show greater preference for low arousal music compared to Western European and Latin American countries, which would both show a similar preference for high arousal music. Second, we hypothesised that there would be no differences in countries' valence preferences, as all countries should show a preference to high valence (positive) music. We also ran additional exploratory analyses assessing relationships between countries' cultural dimensions, and their top Spotify songs' valence and arousal.

METHOD

In total, 32,400 songs were drawn from Spotify weekly charts across 12 months from 27 countries (nine countries grouped into three culturally similar regions; Western-European, East-Asian, and Latin-American). The valence and energy of music from these countries, extracted from the Spotify API, was examined between cultural groups. This was also examined within the context of six cultural dimensions: power distance index, individualism/collectivism, uncertainty avoidance, masculinity/femininity, long/short-term orientation, and indulgence/restraint.

RESULTS

Consistent with existing research on cross-cultural ideal affect, we found that Western-European countries preferred higher arousal music than East-Asian countries, and Latin American countries preferred the highest arousal music. In addition, both Western countries and East Asian countries showed a similar preference for neutral valence music. This contradicted the expected universal preference for positive valence, which was evident only for the Latin American countries. Finally, high uncertainty avoidance was associated with positive valence and high arousal in music, and positive valence was also associated with higher indulgence, and lower long-term orientation.

DISCUSSION

These results provide evidence that cultural differences in ideal affect map on to cross-cultural music preferences, and that these preferences relate to several cultural dimensions. We suggest that national music preferences, a mostly untapped data resource, could be a useful proxy for discerning cultural ideal affect, emotions, and their relationship to listener behaviour.

WORKSHOPS

SpotiPy: getting started with APIs for music research

Rory J.D. Kirk

University of Sheffield, Sheffield, United Kingdom

For better or worse, the internet has become entangled in so much of our lives. The abundance of data online has provided a way for researchers to explore all manner of topics and human behaviors, from studying shopping habits to analyzing public discourse on Twitter. Application program interfaces (APIs) are software intermediaries provided by some websites that allow access to certain data related to their content. Access is typically gained by writing small computer programs in a language such as Python to send 'requests' to those websites to retrieve specific information. While this does require a degree of technical know-how and coding skills, acquiring those skills is becoming increasingly accessible, and they can be a valuable asset in a researcher's toolkit for both qualitative and quantitative research. In this workshop, we will look at how to access the Spotify API and use it as a tool for music research, both theoretically and practically with the opportunity for some hands-on coding. The workshop is intended to be accessible to all, with the possibility for various levels of engagement depending on technical skill. A basic knowledge of programming is useful, but not essential.

Research in the wild

Maruša Levstek

StoryFutures, Royal Holloway, University of London, United Kingdom

This workshop will focus on conducting music research "in the wild" – in real-life music contexts, as opposed to in the lab. It will cover a range of inter-disciplinary quantitative and qualitative research methods, including surveys (i.e. how to ensure high survey up-take), interviews and focus groups (i.e. how to recruit and create space where participants feel safe to contribute and open-up), observations (i.e. in what context can research observations be appropriate and what steps should the observer take in order to ensure the participants are comfortable with being observed), as well as ethnographic approaches (i.e. what is the value of being a researcher-participant), particularly focusing on video ethnographic approaches (i.e. how using a camera will change your life as a researcher in the wild).

Introduction to spatial audio & room acoustics

Bart Moens

IPEM, Ghent University, Ghent, Belgium

The workshop starts with a short overview of the speaker setup in the lab, followed by an introduction to higher-order ambisonics. The main part of the workshop is a hands-on session to explore and create a spatial audio piece on the 80-speaker setup, with a final downmix to binaural audio. Finally, we conclude with a short demo about room acoustic simulation, combining both the speaker setup and binaural audio.
Requirements: Laptop with Ableton Suite 11 (trial, https://www.ableton.com/en/trial/) + envelop4live (https://github.com/EnvelopSound/EnvelopForLive) + headphones.

Introduction to Motion Capture for performance

Adriana Parente La Selva, Ioulia Marouda

IPEM & S:PAM, Ghent University, Ghent, Belgium

This workshop aims to introduce participants to the possibilities and challenges of motion capture. For this we will use the Qualisys tracking system which is installed in our ASIL Lab. After a small introduction, participants will receive a short movement workshop and create a dancing score. They will be divided in two groups; the first group will be wearing MoCap suits and will have their movement captured while the second will be dancing with the use of tracked props. They will then have the chance to perform their score, while being tracked by our 14 infra-red cameras. Practical details like skeleton creation, data clean-up and exporting for game engines will be demonstrated.

Interactive settings for interacting brains: Dual-EEG approaches in music research

Mattia Rosso

IPEM, Ghent University, Ghent, Belgium

'Hyperscanning' is an umbrella term referring to simultaneous recording of brain activity involving multiple participants. The approach has recently seen a rise in popularity (and arguably hype) across research domains related to human interactions and joint action. Since embodied music cognition pertains to these domains, in 2019 IPEM decided to implement a dual-EEG setup in its facilities with three goals in mind: 1) grasping neural dynamics at the millisecond-scale, 2) recording two interacting subjects at a time and 3) allowing a certain degree of mobility during experimental musical tasks. During the first half of the program, we will show how to set up a dual-EEG recording in the context of a joint rhythmic task. The activity will be hands-on, but we will skip the more tedious parts of preparing participants to jump into the core of the program, namely situating the technical setup in a discussion on music research. The second part of the workshop will consist of an interactive discussion where we think critically together about hyperscanning, its neurophysiological meaning, its meaning for music research and, perhaps most importantly, recognize its limitations. The workshop will be closed with a Q&A session held by a representative of ANT Neuro, namely the manufacturer of the showcased EEG system and one of the sponsors of SysMus '22.

Analog and digital sound synthesis

Bavo Van Kerrebroeck

IPEM, Ghent University, Ghent, Belgium

This workshop will introduce participants to digital sound synthesis using the Max MSP application and analog sound synthesis using the historical EMS Synthi 100. Participants will get an extensive introduction to working with the Max MSP software and learn various ways to deal with audio and control signals. They will learn several ways to process audio such as filters, ring modulation, FM synthesis, reverberation and play with these in both the digital and analog domains.
Requirements: Laptop with Max MSP (trial, https://cycling74.com/downloads), headphone if possible.

DEMOS

Be Hear Now – an interactive, audiovisual cityscape

Lennert Carmen[1], Xander Steenbrugge, Bavo Van Kerrebroeck[2], Pieter-Jan Maes[2]
[1]RICTS, School of Arts, Brussels, Belgium.
[2]IPEM, Ghent University, Ghent, Belgium

This room presents an installation created at the Art-Science-Interaction Lab of IPEM at Ghent University. In the original setup, visitors were motion tracked and stepped on floor-projected words to trigger visuals or Ambisonic and stereo field recordings from the city of Ghent. At the start of the installation, visitors entered the room and were immersed in an audio mix of third order Ambisonic field recordings. After a minute, they heard the sound of windows closing after which three words were projected on the floor. When a visitor stepped on one of the words, they triggered one of the three cityscapes themed "water", "culture" and "night". Words were again projected on the ground that lifted audio filters on the audio when visitors stepped on them. This was done to give the impression of windows opening and letting the cityscape sounds enter the room. In this minimal implementation, we show the three videos and a binaural mix of the field recordings. https://hub.link/3ocpWXV

Wearable sensors for physiological monitoring during music playing and learning

Francesco Di Tommaso
Università Campus Bio-Medico di Roma, Rome, Italy

After a brief introduction to the technology of wearable sensors for physiological monitoring and their main uses in different situations, the demo will show the real use of the devices and give some hints about the music playing and learning scenario planned in the European project CONBOTS (CONnected through roBOTS: physically coupling humans to improve handwriting and music learning). In particular, participants will be shown how to properly wear the sensors, connect them to a laptop, and collect data by means of specially developed software. Finally, samples of recorded data will be presented, preliminary analysed, and discussed.

Zactrack, what to expect from an automated follow system & TiMax, evolutionary immersive spatial audio

FACE company
FACE, Boom, Belgium

Zactrack SMART is the world's first plug and play automated follow system. It uses self-measuring "mesh network technology" to accurately calculate the dimensions of the stage without using any measurement aid. System setup takes less than 15 minutes from unpacking the system components to 3D tracking for stage lighting, sound or video effects.
Timax, the world's first fully commercialized audio-show control system for source-oriented reinforcement (SOR) in theatre, presentation and events.

Being Hungry – a spatial audio composition at the Arts-Science-Interaction-Lab

Celien Hermans[1], Bavo Van Kerrebroeck[2], Bart Moens[2], Pieter-Jan Maes[2]
[1]RICTS, School of Arts, Brussels, Belgium.
[2]IPEM, Ghent University, Ghent, Belgium

This virtual room presents an extension of the work 'Being Hungry' composed by Tineke De Meyer and Duncan Speakman. Being Hungry was written at the beginning of spring as some of us entered lockdown. Inspired by the book Jonathan Livingstone Seagull by Richard Bach, it imagines a small group of people that decided to devote themselves to the practice of just walking, a passion for moving around without distinctive aim. We tried to reimagine this work by spatializing the different audio layers using trajectories designed in virtual reality. Trajectories were generated using random walk equations and enriched with gestures, hand-draw in virtual space or recorded from algorithmic swarm patterns. https://hub.link/Z2qbhLA

States of Water – Practicing Odin Teatret Archives

Ioulia Marouda, Adriana Parente La Selva
IPEM & S:PAM, Ghent University, Ghent, Belgium

Practicing Odin Teatret Archives is a research project which draws on new approaches in Performance Studies for studying theatrical training techniques through archival reconfigurations in virtual reality. In this experiment, we have explored the potential of XR technologies (immersive audio-visual displays, and embodied interaction interfaces) as an alternative learning method for performers, using Odin Teatret actress Roberta Carreri's exercise called Six States of Water as a departure point. Each of the six states of water was designed as a virtual scenario on 3D audiovisual displays, which evoke the embodied qualities inherent to each state of water. Through interdisciplinary dialogues between the fields of Performance Studies and Computational Modeling, this demo displays three of these states of water (fog, little creek and iceberg) as interactive environments that react to a user's movement. By touching the virtual waters, the environment becomes responsive: the waters move/ are moved by a person's touch, leaving traces of this contact resonating in the virtual space which, in return, vibrates the qualities of these waters in the person's body, synchronising patterns of movement. This process of mutual synchronisation renders the archive a learning-with assemblage.

Real-time, full-body skeleton tracking in extended reality using the Qualisys motion-capture system

Erwin Schoonderwaldt[1], Bavo Van Kerrebroeck[2]
[1]Qualisys AB, Göteborg, Sweden.
[2]IPEM, Ghent University, Ghent, Belgium

This demo will demonstrate how to use the Qualisys motion capture system to stream and render full-body, human-controlled animations as avatars in extended reality. Visitors will have the opportunity to see all steps in the capturing, recording and rendering process. From motion capture settings, to skeleton rendering in Qualisys's track manager QTM, streaming into the Unity application and finally rendering in a VR and AR head-mounted display.

An interactive spatial sound installation using binaural synthesis

Claudia Stirnat[1,2]
[1]State Institute for Music Research, Berlin, Germany.
[2]Technische Universität Ilmenau, Germany

Try out and experience the interactive spatial sound installation. In an introduction, you will learn how the installation works, and after your listening experience, look behind the scenes at how the installation was created. In this video example, a listener hears an auditory augmented reality scene in an interactive spatial audio installation using binaural synthesis. He can move within the marked listening area and hears the sound through headphones. Virtually, there exist six sound sources visualized as white loudspeakers in the picture of which five are outside the listening area and one is inside the listening area. While watching the video with headphones, you will hear the sound from the listener's perspective and the way he experiences the scene. When he moves towards a sound source, you will hear the sound coming closer to you and when he walks away, you will hear the sound source disappear as well. He experiences the virtual sound sources externally, outside his head. Additionally, there is also an internalized voice, that he experiences inside the head as if someone is listening via headphones as usual. The listener's task is to go through the augmented reality scene, made as a spaceship, interactively and find triggers within the listening area to activate the following sound events to find the end of the installation.
It will be a lot of fun and a listening experience you will enjoy!
Listener: Julius Prenzel; Installation created by: Max E. Stelzenmüller, Julian Wentz, Rasmus L.L. Merten; Video editing: Claudia Stirnat

PianoPhase – measuring social presence in extended reality

Bavo Van Kerrebroeck, Giusy Caruso, Pieter-Jan Maes

IPEM, Ghent University, Ghent, Belgium

Here, we introduce a study aimed at developing a methodological framework to evaluate musical interaction qualities in virtual reality. Specifically, we had a pianist wearing a VR headset perform the piece "Piano Phase" three times: with a real partner, a human-controlled virtual partner and a computer-controlled virtual partner. We then evaluated musical performance, embodied co-regulation and the subjective experiences using a combination of quantitative and qualitative methods. This demo illustrates the experimental case-study using YouTube videos from both the experimental conditions and an artistic performance.
https://youtube.com/playlist?list=PL_9jB_2tw40wMNSR-Sa8Wsdhk4c2JJsHs

Sonic Breathing – a distance-based, sonified breathing biofeedback system

Bavo Van Kerrebroeck, Pieter-Jan Maes

IPEM, Ghent University, Ghent, Belgium

The link below guides you to a Github repository where you can download a breathing sonification app, try this at home! The app was developed to investigate the use of auditory feedback to manipulate breath patterns and induce states of relaxation. All you have to do is:
Download and install the app; Sit comfortably; Wear headphones; Launch the app and indicate your breathing onsets using the keyboard (https://github.com/ArtScienceLab/SonicBreathing)

Two applications in virtual reality: Lines And Swarms – A spatial audio composition tool in virtual reality & XRHive, reliving the sound world of IPEM in the 1960s

Bavo Van Kerrebroeck, Ioulia Marouda, Pieter-Jan Maes

IPEM, Ghent University, Ghent, Belgium

Lines And Swarms: Sound spatialization offers rich additional ways for the expression of emotions, creative narratives, and imaginative thoughts and feelings in music. A core question pertains to the arrangement and control of sound trajectories in 3D space. The aim of this application is to fully exploit the artistic and creative potential of rendering gestural, imaginative expressions and repertoires into corresponding sound trajectories in 3D space. In addition, this project aims to explore the complementarity of VR visual displays in the arrangement and experience of gesture-based 3D sound trajectories. This demo will present the "Lines and Swarms" application, a first prototype to spatialize audio trajectories in virtual reality.

XRHive: IPEM was founded in 1963, and provided a sound and research lab for important pioneers in electronic and electroacoustic music, such as Lucien Goethals, Louis De Meester and Karel Goeyvaerts. Numerous electronic sound generators and modules (predecessors of the analog modular synthesizers) were built that were adjustable in frequency (pitch), waveform (sound color), amplitude (loudness), etc., providing composers with an inexhaustible source of new sounds and creative experiments. XRhive aims to relive the IPEM sound studio of the 1960s in virtual reality (VR). In collaboration with the Musical Instruments Museum (MIM, Brussels), 3D virtual models of various historical sound modules were created. A room was then created in VR where users can play and hear the sound instruments of "back in the days". With XRhive, we try to contribute to new impulses regarding the conservation of, and interaction with, cultural heritage.