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The Effects of Different Types of Music Practice on Wellbeing and Humor

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THE EFFECTS OF DIFFERENT TYPES OF MUSIC PRACTICE ON WELLBEING AND HUMOR

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RESUMO

A investigação empírica sobre o impacto da prática musical no domínio afetivo é escassa, apesar da sua relevância para a musicoterapia. No presente estudo, pretendemos determinar se a prática musical melhora o bem-estar e o humor em comparação com atividades não musicais e ver se estes efeitos variam de acordo com o tipo de prática musical (exploração vs. execução vs. composição). Para o efeito, analisámos os efeitos de três atividades musicais (explorar uma concertina, aprender a tocar uma música no piano, e compor uma peça musical utilizando software indicado) contra três análogos não musicais (explorar blocos de Lego, repetir sequências de teclas de computador, mobilar uma sala utilizando software indicado) sobre mudanças autopercecionadas de bem-estar e humor, e sobre possíveis correlatos EEG destes (alterações espectrais). Utilizámos cinco medidas comportamentais de bem-estar e humor: Despreocupação, Alegria, Entusiasmo, Abertura (a novas experiências), e Produtividade. Todas, exceto Despreocupação, mostraram efeitos positivos da Música. O Tipo de Atividade Musical com maior impacto foi a Composição, e a que teve o menor impacto foi a Exploração. Os resultados EEG foram inconclusivos, na medida em que não encontrámos alterações relacionadas com as tarefas para nenhuma das bandas de frequência consideradas. Apenas foi observado um efeito principal da banda, com intensidade da banda Delta superior a Alfa e Beta. Os nossos resultados sugerem que a Composição Musical pode ser uma ferramenta ideal para melhorar o bem-estar e humor. Desafiando a ênfase dada à Exploração Musical na musicoterapia, as nossas descobertas sugerem que esta pode não ser a melhor opção para promover o afeto positivo.

Palavras-chave: Eletroencefalografia, Bem-estar, Humor, Prática Musical, Composição Musical

ABSTRACT

Empirical research concerning the impact of music practice on the affective domain is scarce, despite its relevance to music therapy. In the present study, we wanted to determine whether musical practice enhances wellbeing and humor compared to non-musical activities, and see whether these effects vary according to the type of music practice (exploration vs. execution vs. composition). To that end, we analyzed the effects of three musical activities (exploring a concertina, learning to play a tune on the piano, and composing a musical piece using dedicated software) against three non-musical analogs (exploring Lego blocks, repeating sequences of computer keys, furnishing a room using dedicated software) on self-perceived changes of wellbeing and humor, and on possible EEG correlates of these (changes in power in different frequency bands). We used five behavioral measures of wellbeing and humor: Unconcern, Joy, Excitement, Openness (to new experiences), and Productivity. All except Unconcern showed positive effects of Music. The Type of Musical activity with the largest impact was Composition, and that with the lowest was Exploration. EEG results were inconclusive, in that we found no task-related changes in power for any of the frequency bands considered. Only a main effect of band was observed, with Delta power winning over Alpha and Beta power. Our findings suggest that Musical Composition may be an optimal tool to enhance wellbeing and positive humor. Challenging the emphasis given to Musical Exploration in music therapy, our findings suggest that this may not be the best option for boosting positive affect.

Keywords: Eletroencephalography, Wellbeing, Humor, Music Practice, Music Composition

RÉSUMÉ

Les recherches empiriques sur l'impact de la pratique musicale sur le domaine affectif sont rares, malgré leur pertinence pour la musicothérapie. Dans la présente étude, nous avons cherché à déterminer si la pratique musicale améliore le bien-être et l'humeur par rapport aux activités non musicales et à voir si ces effets varient en fonction du type de pratique musicale (exploration vs. performance vs. composition). À cette fin, nous avons examiné les effets de trois activités musicales (explorer un concertina, apprendre à jouer une chanson au piano et composer un morceau de musique à l'aide d'un logiciel indiqué) par rapport à trois activités analogues non musicales (explorer des blocs Lego, répéter des séquences de touches d'ordinateur, meubler une pièce à l'aide d'un logiciel indiqué) sur les changements de bien-être et d'humeur perçus par l'individu, ainsi que sur les corrélats EEG possibles de ceux-ci (changements de POWER ? dans différentes bandes de fréquence). Nous avons utilisé cinq mesures comportementales du bien-être et de l'humeur : l'insouciance, la joie, l'enthousiasme, l'ouverture (aux nouvelles expériences) et la productivité. Tous les effets positifs de la musique ont été observés, à l'exception du sentiment d'insouciance. Le type d'activité musicale ayant le plus d'impact est la composition, et celui ayant le moins d'impact est l'exploration. Les résultats de l'EEG n'ont pas été concluants dans la mesure où nous n'avons trouvé aucune modification de la puissance liée à la tâche pour aucune des bandes de fréquences considérées. Seul un effet principal de la bande a été observé, la puissance de Delta l'emportant sur celle d'Alpha et de Beta. Nos résultats suggèrent que la composition musicale peut être un outil idéal pour améliorer le bien-être et l'humeur. En remettant en question l'importance accordée à l'exploration musicale en musicothérapie, nos résultats suggèrent que ce n'est peut-être pas la meilleure option pour améliorer l'affect positif.

Mots-clés : Electroencéphalographie, Bien-être, Humeur, Pratique Musicale, Composition Musicale

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Introduction

Music is hard to define. Although most people know what it refers to, putting the concept into words is not an easy task. Philosophers, musicologists, and composers have put forward different definitions of music, such as a type of art, a science, a beautiful way of expressing emotions, a reflection of our soul, and, more objectively, a selected combination of sounds organized in time (Maojo, 2019). The psychological substance of music includes both music reception and music production, as well as their interdependent processes (Elliot, 1995). From this viewpoint, we can look at music from two different perspectives: music listening and music practice. In the present study, we will focus on music practice.

1. Types of Music Practice

Within music practice, different types may be considered. The most common is what we will call *Musical Execution*, referring to the act of playing or singing a musical piece composed by others. However, there are other types: one can play an instrument just for the fun and pleasure of doing it, experimenting with the sounds – we will refer to this as *Musical Exploration*. Musical Exploration occurs, for instance, during free improvisation as it happens in music therapy for expressive purposes. Finally, one can create a piece of music as a finished product that be recorded or notated for future reproduction. This usually requires considerable knowledge of music theory as well as instrumental skills, but nowadays, it can be done by non-experts with a computer and musical software. We will refer to this as *Musical Composition*.

2. Effects of exploration, execution, and composition activities on the mind/brain system

While many electroencephalography (EEG) studies rely on the event-related potentials (ERP) technique, approaches to the impact of music on a particular brain state tend to rely on frequency analysis. There are five fundamental widely recognized frequency bands: *Delta (δ)* – < 4 Hz (Kumar & Bhuvaneswari, 2012; Luck, 2014), specifically 0.5-4 Hz (Abhang et al., 2016; Chowdhury, 2020; Rahman et al., 2020) – the slowest, lowest frequency range and highest amplitude, generally not seen in adult brains while they are awake, correspond to the brain state of sleep, dreaming and appear when a person is in most profound meditations; *Theta (θ)* – 4-8 Hz (Abhang et al., 2016; Chowdhury, 2020; Cohen, 2014; Kumar & Bhuvaneswari, 2012; Luck, 2014; Rahman et al., 2020) – correspond to the brain state of deeply relaxed, inward-focused (drowsiness, produced during sleep), associated with relaxation, intuition, emotional connection and creativity; *Alpha (α)* – 8-13 Hz (Chilver et al., 2020; Chowdhury, 2020; Kumar & Bhuvaneswari, 2012; Lopata et al., 2017; Luck, 2014; Papatzikis & Herbst, 2019), which can be divided into Lower (8-10 Hz) and Higher (10-13 Hz) alpha bands (Koivisto et al., 2022) – correspond to the brain state of passive attention (reflective, restful), very common in adults when awake but relaxed (generally with eyes closed, disappearing when opened), being highly associated with stress relieving activities such as meditation, and found in almost every part of the brain, mostly in the occipital lobe (Abhang et al., 2016; Rahman et al., 2020); *Beta (β)* – 13-30 Hz (Chowdhury, 2020; Kumar & Bhuvaneswari, 2012; Luck, 2014) – identified as high-frequency brain waves with low amplitude, reflecting the active state of the brain (external attention as a busy, active mind), engaged in logical thinking, conscious thought, affect, alertness and attention (Abhang et al., 2016; Rahman et al., 2020); *Gamma (γ)* – > 30 Hz (Chowdhury, 2020; Kumar & Bhuvaneswari, 2012; Luck, 2014), with Cohen (2014) suggesting a division into Lower Gamma (30-80 Hz) and Upper Gamma (80-150 Hz) – the fastest brain waves with small amplitudes, corresponding to the brain state of concentration and problem solving thought to increase cognitive function and boost focus and memory (Abhang et al., 2016; Rahman et al., 2020). Frequency analyses may take several forms, such as power measurements per band or coherence measures per band.

While the positive effects of listening to music are widely acknowledged, the literature has paid less attention to the effects of music practice. Nevertheless, experts have started claiming that music practice may generate more benefits than listening (Sapega, 2017), and playing an instrument may be one of the best ways to help keep the brain healthy.

Regarding the impact of music practice on cognition, music training is known to be associated with functional changes in the brain, and it can modulate the cortical synchronization of neural networks (Cheung et al., 2017). Learning an instrument or mastering the voice induces changes in the brain's electrical activity. Compared to non-musicians, beta waves of musicians tend to indicate higher levels of attention, and alpha waves suggest that musicians are far more successful at entering a meditative state, possibly because they are more successful at blocking out unnecessary thoughts and mental activities

(Donnelly, 2019). Individuals with music training demonstrate better verbal memory than those without music training during both the learning and the delayed recall trials. They also exhibit greater learning capacity and show an increase in long-range left and right intrahemispheric EEG coherence in the theta frequency band. Moreover, their event-related left intrahemispheric theta coherence is positively associated with subsequent verbal memory performance as measured by discrimination scores (Cheung et al., 2017).

A review paper by Cantou et al. (2018) focused on analyzing the resting-state functional connectivity (rs-FC) – effects of musical expertise on whole-brain plasticity without any task – and the resting-state functional networks (RSN) – frequency oscillations synchronized. The authors state that compared to non-musicians, professional musicians show higher rs-FC within brain networks related to musical practice, specifically an increased connectivity between the left and the right auditory cortices and between the left auditory cortex and the right sensorimotor cortex. Also, musical experts exhibited increased connectivity in theta and lower alpha-frequency ranges, which are known to be involved in cognitive functions. The literature shows that engaging in music lessons increases intelligence (Schellenberg, 2011) and that learning how to play an instrument or use the voice improves both musical skills and cognitive ability during challenging non-musical tasks as well (Donnelly, 2019). The advantages of learning to play an instrument are not only for children (life-long benefits) but also for seniors, as taking music lessons at 60 years old or older helps decrease the loss of memory, among other cognitive functions (verbal fluency, information processing speed, and planning ability). Munroe (2021) found that middle school students may be more motivated to problem-solve after creating original music. The author also claims that students may use music to express their knowledge and understanding of various topics, as composing music allows them to create music that embodies their knowledge of music concepts and make links with the worlds around them. Although this positive impact of music practice in cognition reflects long-term musical practice, it is not impossible that some positive effects emerge after a short music practice experience.

Regarding the affective or psychosocial impact of music practice – the present study's focus – a few studies have also pointed to benefits. In *Musical Exploration*, the focus is put on the process and not on the outcome of playing or singing. Music exploration emphasizes process over product, contrary to other forms of performance in which the final goal is the resulting musical object (Menezes, n.d.). In a recent review paper on this topic, Katušić & Burić (2021) cover improvisational music therapy's aspects, including free improvisation and creative music. These activities focus on freedom of expression and on the productive behaviors that may be experienced in the music-making process. The authors highlight the potential of musical exploration to empower participants' psychosocial development, namely regarding self-actualization, creative skills, emotional expression, social perception, and self-regulation.

Musical Execution is about learning and practicing on a regular basis, with the goal of delivering a musical piece to an audience. Playing an instrument engages every major part of the central nervous system (as motor control, executive functions, sensory inputs), and it may be a unique form of brain exercise. An interesting outcome regarding wellbeing states that people can get immediate benefits from playing an instrument, as it acts like a stress reliever and brings people together (Sapega, 2017).

Concerning the last type of *Musical* practice – *Composition* – the literature on its psychosocial impact shows some interesting effects. According to Habron et al. (2013), using creative media is an activity that may enhance the quality of life and wellbeing. The authors state that composing music evokes powerful emotions and adds significant meaning to people's sense of identity and self-esteem. Music composition – engagement in creative and productive occupations, specifically musical – also empowers and stimulates cognition, enables skills development, and raises confidence, thus apparently contributing to health, wellbeing, and quality of life, at least in the short term. The literature on a specific type of composition – collaborative composition – and its relationship with wellbeing (under the PERMA framework – PERMA wellbeing model) also highlights psychosocial benefits. PERMA framework (Seligman, 2011) defines wellbeing by five components: positive emotion (P), engagement (E), relationships (R), meaning (M), and accomplishment (A). These five building blocks are seen as the intervention's ultimate goal, not just as a means to an end (Positive Psychology Center, 2022). Waddington-Jones et al. (2019) compared the effects of collaborative composition with other forms of group musical engagement. They found that, for older adults, collaborative composition has a great deal to offer as an activity promoting social interaction with others with common interests, increasing self-esteem, and enhancing positive affect. Collaborative composition offers ways to think differently and produce, juxtapose, contrast, combine, and communicate ideas. However, despite the strong evidence for the value of collaborative composition as an activity that may enhance wellbeing, the intersubjective collaborative composition process is complex and requires a range of skills. Therefore, it is essential to develop such methods.

3. Comparison between types of music practice

Comparative studies addressing the effects of different types of music practice, whether cognitive or psychosocial, are scarce. One interesting study investigated the differences in frontal brain activity occurring between tasks with high and low creativity demands. Lopata et al. (2017) recorded EEG activity while musicians listened to, played back, and improvised jazz melodies, activities that represent music listening, music execution, and – roughly speaking - music composition (jazz improvisation combines the creative and intellectual aspects of musical composition with on-the-fly musical exploration). The authors took into consideration the previous Formal Institutional Training in Improvisation (FITI) of the participants, and the analyses revealed that, amongst those with previous FITI, frontal upper alpha synchronization was greater while improvising (spontaneous composition) than while (deliberately) playing back melodies, and even more remarkable than while just listening to melodies (passively). The effect was greatest in the right hemisphere. This was interpreted as evidence of a creative mental state. This state would be characterized by spontaneous processing and most probably by a degree of top-down inhibition and internal focus of attention, which are attributes of competitive and concurrent interactions of default and control networks during a generative artistic performance. Also, immersing in such a creative mental state (upper alpha synchronization) was associated with higher-quality creative products, and this was more evident for the participants with previous FITI than for the ones without it. Finally, task-related differences (in upper alpha synchronization) backed the perspective that creativity can be conceptualized as a distinguishable mental state that occurs in the course of spontaneous musical performance.

4. The Current Study

Despite the vast amount of literature on the multiple effects of music listening and on the cognitive effects of music practice, studies on the affective/psychosocial effects of music practice are scarce. To our knowledge, beyond Lopata et al.'s (2017) study, there are no studies comparing different types of music practice and even this study missed the exploration and composition components as we described them. In the current study, we tried to address this gap with an explorative study comparing the effects of three types of music practice – Exploration, Execution, and Composition – on self-perceived changes of wellbeing and humor and possible EEG correlates of these. To that end, we compared these activities with non-musical analogs: playing with legos (exploration), repeating a sequence of keyboard keys (execution), and furnishing/decorating a room (composition). Self-perceived changes in humor and wellbeing were evaluated with questions concerning the degree of change felt by participants in aspects like agitation, focus, or joy after completing each of the six tasks, compared to how they felt before it. With this design, we would be able to determine (1) whether the effects of music practice are beneficial (music vs. non-music) and (2) whether any of the three types of practice holds advantages over the others.

To investigate possible EEG correlates of behavioral effects, we did frequency analysis of EEG recorded during resting state before and after the activity and compared power at each frequency band across these two moments (pre- vs. post-activity). Regarding EEG markers of wellbeing, the literature states that EEG frequency bands strongly correlate with positive and negative emotional responses (Chowdhury, 2020). For instance, Frontal Alpha Asymmetry (FAA), defined as the difference between right and left alpha activity over frontal regions of the brain (Davidson et al., 1990), may characterize the polarity and intensity of emotions. More specifically, greater left frontal activity (lower alpha power) is associated with a more intense response to affectively positive stimuli, whereas greater right frontal activity (or, possibly, lower left frontal brain activity) is associated with an increased tendency to more intensely respond to negative affective stimuli (Fischer et al., 2018). Therefore, alterations in FAA found in the EEG can be correlated with emotional/motivational personality traits (Reznik & Allen, 2018). This is in line with Chowdhury et al. (2020), who state that alpha frequency power in the left and right front cortical area correspond to negative and positive emotions, respectively.

In contrast, Chilver et al. (2020) examined the resting EEG profiles associated with mental wellbeing and found significant associations that did not include frontal asymmetry. Instead, the authors found a significant three-way interaction between alpha, beta, and delta power (ABD), in which a profile of high alpha and delta in combination with low beta was associated with elevated wellbeing (Chilver et al., 2020). The authors concluded that the ABD interaction predicts wellbeing. Additionally, the authors give one possible explanation for the lack of asymmetry, which is the lack of any emotional manipulation in their study. Since we were focused on measures and wellbeing and humor, and not exactly on emotional experiences, we analyzed our EEG data for ABD.

Based on evidence that music practice may promote wellbeing and on the apparent advantages of creative work compared to musical execution (Lopata et al., 2017), we hypothesized that music activities would be more beneficial than non-music to wellbeing and humor, and musical composition might have an advantage over execution.

Methods

1. Participants

According to a priori power analyses made in G*Power (Faul et al., 2007) for EEG results (Type of Activity x Time x Music x Frequency Band), in order to capture a medium effect size with 80% power and critical alpha of .05, we would need 15 subjects.

Forty-seven musically naïve participants volunteered to take part in the experiment. Eleven were excluded due to excessive EEG artifacts and/or outlier values. Within the remaining 36, 25 were women and 11 were men (24 identified with the female gender, 11 with male, one with no response). Ages ranged between 18 and 49 years ($M \pm SD$ = 24 $\pm$ 7.89). On average, they had 14 years of schooling (*SD* = 2.32). None reported habits or health conditions that could interfere with the EEG or behavioral responses, and none had had musical training for more than a year.

Gold-MSI scores showed average values, with the General Musical Sophistication Factor having a mean of 4.22 and a standard deviation of 1.83. The same went for EBEP, with mean values neither too high nor too low ($M \pm SD$ = 5.18 $\pm$ 1.50). Thus, we had a sample of individuals with average musical sophistication and average basal levels of wellbeing.

The study was approved by the local ethics committee, ref 2021/09-06b, and by the data protection services (ref 2021122315000082). The experiment was publicized by the University's communication services, by email, and in social media. Those interested in participating should send an email and fill out an online questionnaire with contact information so that the session could be scheduled. Inclusion criteria were not having visual, hearing, or motor problems, and having less than a year of formal music training. Participants did not receive any monetary compensation. They all signed informed consent according to the Declaration of Helsinki.

2. Instruments

Along with the experimental task, participants filled in four different questionnaires: a questionnaire for collecting relevant sociodemographic information; the Goldsmiths Musical Sophistication Index (Gold-MSI, Müllensiefen et al., 2014), validated for Portuguese by Lima et al. (2018); a Psychological Wellbeing Scale (Ryff, 1989) with 42 items, validated for the Portuguese population (Escala de Bem-Estar Psicológico, EBEP) by (Freire et al., 2019); at the end of the experiment, participants rated how each of the six experimental tasks (three musical activities and their non-musical analogs) had changed their wellbeing and humor using a scale that we created based on available instruments. The goal was to obtain behavioral measures of impact on wellbeing and humor for cross-checking with the EEG data. For each instrument, the original authors were informed and authorized the use of their intellectual property.

2.1. The Goldsmiths Musical Sophistication Index (Gold-MSI)

To characterize participants' relationship with music, musicality, and basal level of musical sophistication, we used the Gold-MSI. It consists of a self-report measure of musical skills and behaviors in the general (i.e. non-specialist) population. It comprises 38 items, which cover five specific domains: Active Engagement (9 items), Perceptual Abilities (9 items), Musical Training (7 items), Singing Abilities (7 items), and Emotions (6 items). There is also a General Musical Sophistication composed of 18 items belonging to the five subscales. The score obtained in the general factor ranges between 1 and 7, with higher scores representing higher General Musical Sophistication. The Gold-MSI has good internal consistency (Lima et al., 2018).

2.2. Psychological Wellbeing Scale [Escala de Bem-Estar Psicológico, EBEP]

To measure participants' basal levels of psychological wellbeing, we used EBEP. It consists of a self-report tool that comprises 42 items and measures six aspects of wellbeing and happiness (with seven items each): Autonomy, Environmental Mastery, Personal Growth, Positive Relations with others, Purpose in Life, and Self-Acceptance.

We used only 40 items, as the authors did, removing item 1 from Environmental Mastery and item 1 from Purpose in Life to make it suitable for younger participants (Freire et al., 2019). The score obtained ranges between 1 and 7, with higher scores representing higher psychological wellbeing. The EBEP has good internal consistency.

2.3. Perceived Task-Related Changes in Wellbeing and Humor

We developed an eight-item questionnaire to access task-related changes in wellbeing and humor based on available standardized instruments. For wellbeing, we analyzed the items from EBEP domains and used the ones most suited to evaluate short-term, state-related changes: (1) worrying "about what others think", pertaining to the autonomy domain; (2) feeling more or less competent, indicating self-satisfaction and representing the domain of environmental mastery; (3) feeling more or less willing to try new things, regarding the desire of having new experiences as included in the personal growth domain; (4) feeling more or less confident, representing the domain of self-acceptance.

For humor, we used the Mood and Feelings Questionnaire (MFQ), developed by Angold and Costello in 1987 (Duke University, 2022), as a reference. This questionnaire comprises several descriptive phrases about how the individual has been feeling or acting recently. We used the Adult Self-Report – Short Version and referred to the domains of (5) unhappiness/happiness, (6) exhaustion/excitement, (7) restlessness/calmness, and (8) unfocused/focused to create the questions.

3. Procedure

The experimental session took place at the Speech Laboratory (Neurocognition and Language Research Group), located at the Faculty of Psychology and Educational Sciences of the University of Porto. Participants started by signing the informed consent and filling in the sociodemographic questionnaire, EBEP, and Gold-MSI.

Participants were then prepared for EEG recording and performed three types of tasks – *Exploration*, *Execution*, and *Composition* – under two versions – *Musical vs. Non-Musical*. We had, thus, three musical and three non-musical tasks. The six tasks are presented in Table 1.

Table 1

Tasks by Condition (Music x Type of Activity), description, and instructions provided.

Music	Type of Activity	Description	Instructions
Musical			
	Exploration	Sonic exploration using an unfamiliar instrument (concertina)	"Please explore freely the sounds produced by the concertina without aiming to create a final piece."
	Execution	Playing a simple and well-known musical piece on a piano keyboard after a demonstration	"Please choose one of these simple pieces of music on the piano. I will teach you to play by playing small blocks that you will repeat and put together as much as possible."
	Composition	Computer-based composition of a short piece	"Please compose a song to your liking comprising two distinct and coherent parts using the available musical layers."
Non-Musical			
	Exploration	Manipulating lego blocks	"Please explore what you can do with these blocks without aiming to build something final."
	Execution	Reproducing sequences of keys in a computer keyboard	"I will teach you a sequence of keys on this computer keyboard and ask you to repeat and put together the small blocks as much as possible."
	Composition	Furnishing a house within a computer game	"Please furnish two rooms of this house to your taste but distinctly and coherently."

We created six experiment versions for counterbalancing, differing in task order; Those are presented in Table 2.

Table 2

Versions of the experiment resulting from counterbalancing tasks.

Version	Task number	Which task
One	First	Musical Exploration
	Second	Non-Musical Exploration
	Third	Musical Execution
	Fourth	Non-Musical Execution
	Fifth	Musical Composition
	Sixth	Non-Musical Composition
Two	First	Non-Musical Exploration
	Second	Musical Exploration
	Third	Non-Musical Execution
	Fourth	Musical Execution
	Fifth	Non-Musical Composition
	Sixth	Musical Composition
Three	First	Musical Execution
	Second	Non-Musical Execution
	Third	Musical Composition
	Fourth	Non-Musical Composition
	Fifth	Musical Exploration
	Sixth	Non-Musical Exploration
Four	First	Non-Musical Execution
	Second	Musical Execution
	Third	Non-Musical Composition
	Fourth	Musical Composition
	Fifth	Non-Musical Exploration
	Sixth	Musical Exploration
Five	First	Musical Composition
	Second	Non-Musical Composition
	Third	Musical Exploration
	Fourth	Non-Musical Exploration
	Fifth	Musical Execution
	Sixth	Non-Musical Execution
Six	First	Non-Musical Composition
	Second	Musical Composition
	Third	Non-Musical Exploration
	Fourth	Musical Exploration
	Fifth	Non-Musical Execution
	Sixth	Musical Execution

Before and after each task, the resting state EEG of participants was recorded. They were asked to focus on a cross in the middle of the screen with their eyes open and remain as relaxed and stable as possible. In total, they went through seven resting periods (one before the first task and six after the tasks).

At the end of the session, participants reported their perceived task-related changes in wellbeing and humor for the six tasks. The leading researcher stayed in the room with the participant throughout the whole session. In total, the experiment lasted between 90 and 120 minutes.

4. EEG recording and signal preprocessing

The electroencephalographic activity was measured using the BioSemi ActiveTwo system (BioSemi, 2022). Sampling frequencies were set to 500 Hz, and a 100 Hz lowpass filter was applied during recording. The EEG was recorded from 64 active channels (Fp1, AF7, AF3, F1, F3, F5, F7, FT7, FC5, FC3, FC1, C1, C3, C5, T7, TP7, CP5, CP3, CP1, P1, P3, P5, P7, P9, PO7, PO3, O1, Iz, Oz, POz, Pz, CPz, Fpz, Fp2, AF8, AF4, Afz, Fz, F2, F4, F6, F8, FT8, FC6, FC4, FC2, FCz, Cz, C2, C4, C6, T8, TP8, CP6, CP4, CP2, P2, P4, P6, P8, P10, PO8, PO4, and O2), with electrodes placed according to the 10–20 electrode system. Three additional electrodes (M1, M2, and EXT) were placed – the first two for referencing and placed at the mastoids, and one for vertical EOG, placed on the left cheek about 2 cm below the left eye (total of 67 electrodes). Signal quality was controlled using the Biosemi-specific method. Triggers were placed at the onset and offset of each resting period and at the onset and offset of each task. We also placed triggers in the middle of each resting period. These triggers defined all the conditions that matter to us, which were mainly the resting period before and after each task (so that we could compare them afterward); so we had: Pre Musical Exploration, Post Musical Exploration, Pre Non-Musical Exploration, Post Non-Musical Exploration, Pre Musical Execution, Post Musical Execution, Pre Non-Musical Execution, Post Non-Musical Execution, Pre Musical Composition, Post Musical Composition, Pre Non-Musical Composition, and Post Non-Musical Composition. We recoded each participant's triggers so that they could match the respective counterbalancing version.

The EEG data was processed offline using the FieldTrip toolbox for EEG/MEG-analysis, developed at the Donders Institute for Brain, Cognition and Behaviour (Oostenveld et al., 2010; http://fieldtriptoolbox.org), running under MATLAB (v. R2021b; 2021, The MathWorks, Inc., Natick, MA, USA).

First, we doubled the triggers to do the recoding explained above. The data was then bandpass filtered (0.01-60 Hz). Channels with low-quality data (excessive noise or excessive drift) were removed and then interpolated using spherical interpolation. The signal was submitted to an Independent Component Analysis (ICA) to identify and eliminate artefacts that included eye movements, eye blinks, muscular artifacts, and heart rate. The noisy components were identified based on visual inspection of the ICs and then corrected. The signal was re-referenced to averaged mastoids. We defined epochs from -2 sec to 120 sec around the resting-state onset trigger. Epochs were subjected to frequency (power spectrum) analysis using 59 frequency bins. Grand average was computed, and frequency values were grouped into five frequency bands: delta (1-4 Hz), theta (5-8 Hz), alpha (9-13 Hz), beta (14-30 Hz) and gamma (31-59) bands. Mean values per band, condition, and subject were finally exported for statistical analysis.

5. Statistical Analysis

Behavioral data were analyzed with R. 4.1.3 (R Core Team, 2022) and JASP v. 0.16.3 (JASP Team, 2022). We used the R packages "psych" version 2.1.9 (Revelle, 2021) for exploratory factor analyses and "ltm" (Rizopoulos, 2006) to compute the reliability of our measures (Cronbach's alpha).

Before analyzing, we defined our constructs by naming each item mentioned above (see Instruments section) as: (1) Unconcern, (2) Competence, (3) Openness, (4) Confidence, (5) Joy, (6) Excitement, (7) Agitation, and (8) Focus. The eight items assessing task-related changes (task conditions collapsed) were submitted to exploratory factor analysis to see if we could find any underlying factor structure that described our data relating to changes in wellbeing and humor. We then ran repeated-measures ANOVAs on the resulting structure, using Type of Activity (*Exploration*, *Execution*, *Composition*), Music (*Musical vs. Non-Musical*), and Time (*Pre vs. Post task*) as factors, and the amount of change reported as dependent variable.

EEG data were also analyzed with repeated measures ANOVAs in JASP (power per Type of Activity x Music x Time x Frequency Band). In all analyses, the threshold for statistical significance was $\alpha = .05$. Violations of sphericity were corrected by the

Greenhouse-Geisser method. Significant main effects for factors with more than two levels and significant interactions were examined with post-hoc analyses using Holm corrected comparisons.

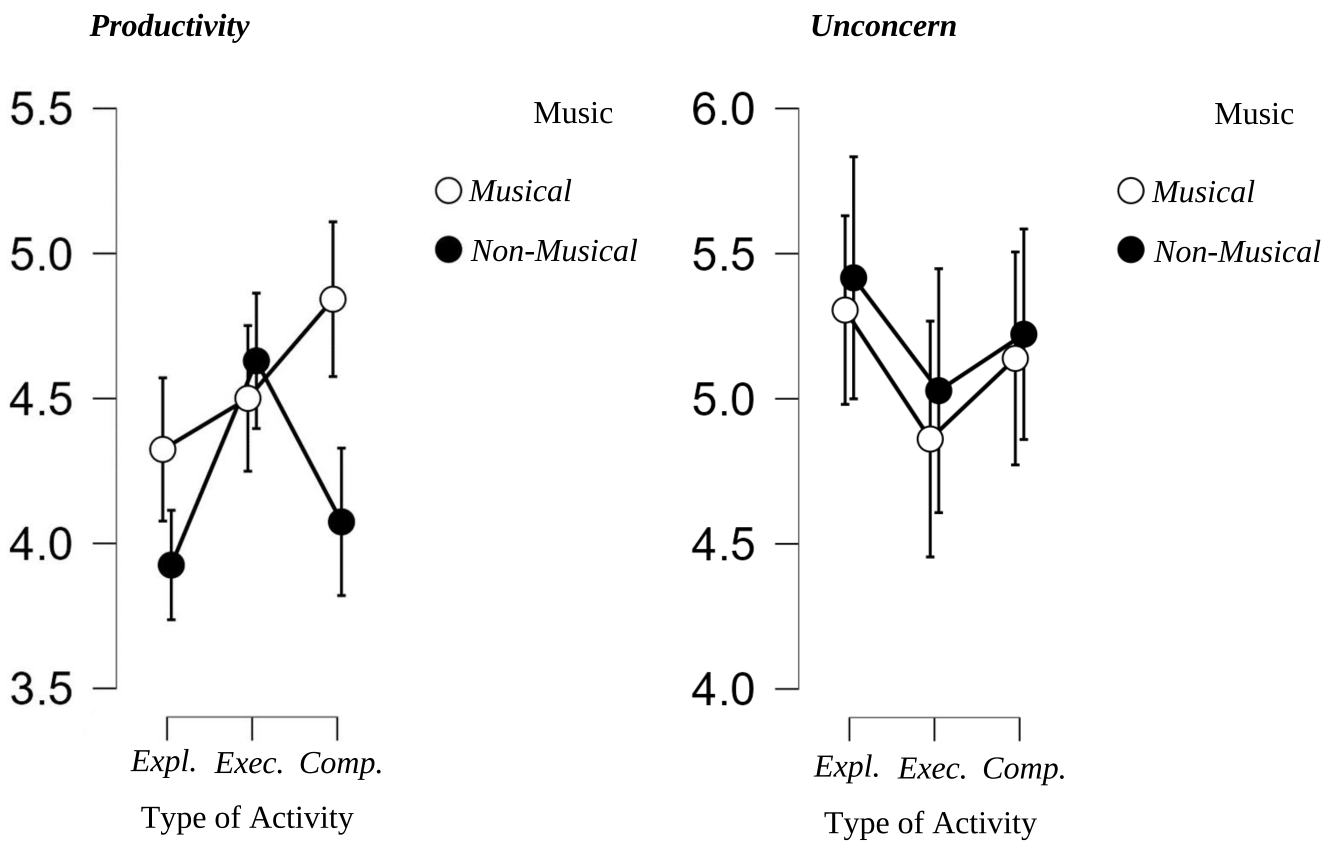
Results

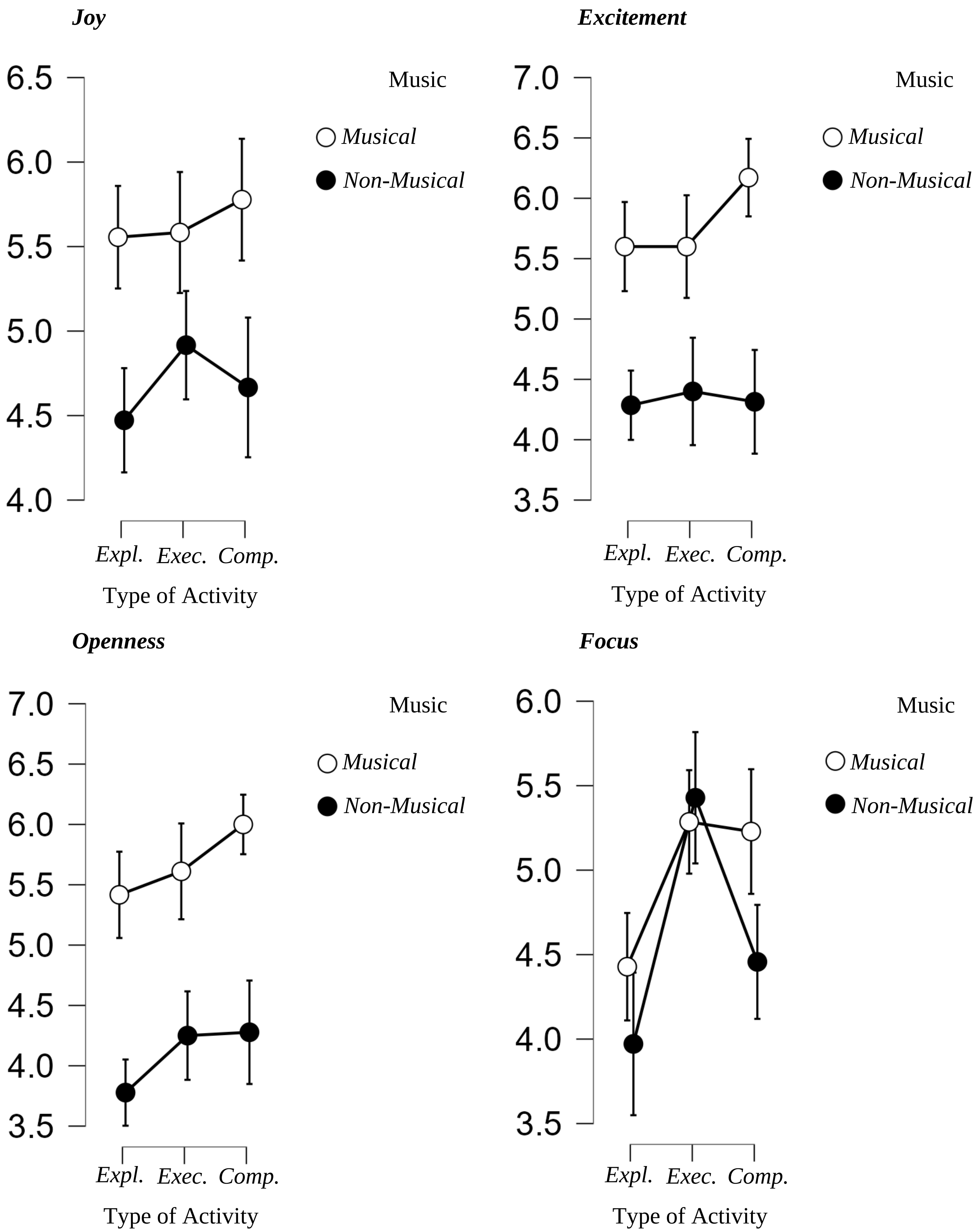
1. Behavioral Data

The effects of Music and Type of Activity on wellbeing and humor are displayed in Figure 1.

Figure 1

Effects of Music x Type of Activity on wellbeing and humor.





Note. Error-bars represent 95% within-subjects confidence intervals.

Caption: Expl. – Exploration; Exec. – Execution; Comp. – Composition

1.1. Productivity Factor: Interaction Music x Type of Activity

In the exploratory factor analysis, we used principal axis factor analysis to extract factors for its relative tolerance of nonnormality, and an orthogonal rotation – Varimax – since we did not request the factors to be correlated. A scree-plot indicated that two factors should be retained accordingly to the guidelines by Williams et al. (2010). We could only extract one robust factor composed of the items Confidence, Competence and Agitation, with loadings of .955, .924 and .561, respectively. We named this *Productivity Factor* since these three psychological states altogether evoke a sense of being invaded by a whirlwind of ideas, active, involved, motivated, flowing in the challenge of doing things, in sum, productive. It explained 28% of the total variance and had a Cronbach's alpha reliability score of .82. As our cutoff for loadings was 0.4, Focus, Openness and Unconcern did not load to any of the factors, leaving the second factor with only two constructs – *Joy* and *Excitement*. In addition, Cronbach's alpha reliability score was unacceptable ($\alpha = .45$) (Kalkbrenner, 2021), so we chose to analyze these five dependent variables independently.

For Productivity, we found a main effect of Music, $F(1,35) = 7.52$, $p = .01$, $\eta_p^2 = .18$, with *Musical* ($M = 4.56$, $SE = .13$) being associated with increased Productivity compared to *Non-Musical* ($M = 4.21$, $SE = .13$). We also found a main effect of Type of Activity, $F(2,70) = 9.94$, $p < .001$, $\eta_p^2 = .22$. A post hoc Holm test showed no significant differences between *Composition* and *Execution* ($p = .30$). There were, though, significant differences between *Composition* and *Exploration*, $p = .004$, $d = .35$ – with *Composition* ($M = 4.46$, $SE = .13$) showing higher productivity than *Exploration* ($M = 4.13$, $SE = .13$), and between *Execution* and *Exploration*, $p < .001$, $d = .46$ – with *Execution* ($M = 4.57$, $SE = .13$) outperforming *Exploration*.

Finally, there was a significant interaction between Music and Type of Activity $F(2,70) = 7.91$, $p < .001$, $\eta_p^2 = .18$. Post hoc Holm tests showed that *Musical Composition* ($M = 4.84$, $SE = .16$) was associated with more Productivity *than Non-Musical Composition* ($M = 4.07$, $SE = .16$, $p < .001$, $d = .80$). Among comparations between *Musical* tasks, *Musical Composition* was associated with more Productivity than *Musical Exploration* ($M = 4.32$, $SE = .16$, $p = .01$, $d = .26$). In turn, amongst *Non-Musical* tasks, *Non-Musical Execution* ($M = 4.63$, $SE = .16$) was associated with more Productivity than *Non-Musical Composition* $p = .005$, $d = .58$); In addition, *Non-Musical Execution* was also associated with more Productivity when compared to *Non-Musical Exploration* ($M = 3.93$, $SE = .16$, $p < .001$, $d = .15$). All the other interactions were non-significant ($p > .152$), except for some comparisons between tasks that were not analogous in Music neither in Type of Activity, such as *Musical Execution* (M = 4.50, SE = .16) associated with more Productivity than *Non-Musical Exploration* (p = .014 , d = .73), and as *Musical Composition* associated with more Productivity than *Non-Musical Exploration* (p < .001, d = .95) too.

1.2. Unconcern: No effects

For Unconcern, we did not find any significant effects, neither for Music (p = 0.5), nor for Type of Activity (p = .190), or for the interaction between Music and Type of Activity (p = .060).

1.3. Joy: Main Effect of Music

For Joy, we found a main effect of Music, $F(1,35) = 27.26$, $p < .001$, $\eta_p^2 = .44$, with *Musical* (M = 5.64, SE = .18) being associated with more joy/happiness than *Non-Musical* tasks (M = 4.69, SE = .18). We did not find a main effect of Type of Activity (p = .28), neither a significant interaction between Music and Type of Activity (p = .26).

1.4. Excitement: Main Effect of Music

For Excitement, we found a main effect of Music, $F(1,34) = 59.50$, $p < .001$, $\eta_p^2 = .64$, with *Musical* (M = 5.79, SE = .13) being associated with more excitement than *Non-Musical* tasks (M = 4.33, SE = .13). We did not find a main effect of Type of Activity (p = .24), nor a significant interaction between Music and Type of Activity (p = .12).

1.5. Openness: Main effects of Music and Type of Activity

For Openness, we found a main effect of Music, $F(1,35) = 50.97$, $p < .001$, $\eta_p^2 = .59$, with *Musical* (M = 5.67, SE = .19) being associated with an increased desire to try new things compared to *Non-Musical* (M = 4.10, SE = .19). We also found a main effect of Type of Activity, $F(2,70) = 9.048$, $p < .001$, $\eta_p^2 = .205$. A post hoc Holm test showed no significant differences between *Composition* and *Execution* (p = .109). Comparisons were significant for *Composition* and *Exploration*, p < .001, d = .40 – with *Composition* (M = 5.14, SE = .175) associated with an increased desire to try new things compared to *Exploration* (M = 4.60, SE = .175), and between *Execution* and *Exploration*, p = .023, d = .25 – with *Execution* (M = 4.93, SE = .175) associated with an increased desire to try new things compared to *Exploration*. We did not find a significant interaction between Music and Type of Activity (p = .445).

1.6. Focus: Interaction Music x Type of Activity

For *Focus*, we found a main effect of Music, $F(1,34) = 8.62$, $p = .006$, $\eta_p^2 = .20$, with *Musica*l ($M = 4.98$, $SE = .15$) associated with more focus/concentration than *Non-Musical* ($M = 4.62$, $SE = .15$). We also found a main effect of Type of Activity, $F(2,68) = 23.53$, $p < .001$, $\eta_p^2 = .31$. A post hoc Holm test showed significant differences between all the three types of Type of Activity: *Execution* ($M = 5.36$, $SE = .19$) yielded more focus than *Composition* ($M = 4.84$, $SE = .19$, $p = .017$ $d = .41$) and *Exploration* ($M = 4.20$, $SE = .19$, $p < .001$, $d = .92$); on the other hand, *Composition* was associated with more focus than *Exploration* ($p = .006$, $d = .51$).

Finally, there was a significant interaction between Music and Type of Activity $F(2,68) = 4.80$, $p < .011$, $\eta_p^2 = .12$. Post hoc Holm tests showed that *Musical Composition* ($M = 5.23$, $SE = .21$) was associated with more self-reported focus than *Non-Musical Composition* ($M = 4.46$, $SE = .21$, $p = .004$, $d = .61$). Regarding *Musical* tasks, *Musical Execution* ($M = 5.29$, $SE = .21$) was associated with more self-reported focus than *Musical Exploration* ($M = 4.43$, $SE = .21$, $p = .011$, $d = .68$) ; *Musical Composition* was also associated with more self-reported focus than *Musical Exploration* ($p = .017$, $d = .63$). Respecting *Non-Musical tasks*, *Non-Musical Execution* ($M = 5.43$, $SE = .21$) was associated with more self-reported focus than *Non-Musical Exploration* ($M = 3.97$, $SE = .21$, $p < .001$, $d = 1.15$); in addition, *Non-Musical Execution* was also associated with more self-reported focus than *Non-Musical Composition* ($p = .003$, $d = .77$). All the other interactions were non-statistically-significative ($p > .203$), except for some comparisons between tasks that were not analogous in Music neither in Type of Activity: *Musical Execution* was associated with more self-reported focus than Non-Musical Exploration ($p < .001$, $d = 1.04$) and *Non-Musical Composition* ($p = .014$, $d = .66$); *Musical Composition* was associated with more self-reported focus than *Non-Musical Exploration* ($p < .001$, $d = .99$*); Non-Musical Execution* was associated with more self-reported focus than *Musical Exploration* ($p = .002$, $d = .79$).

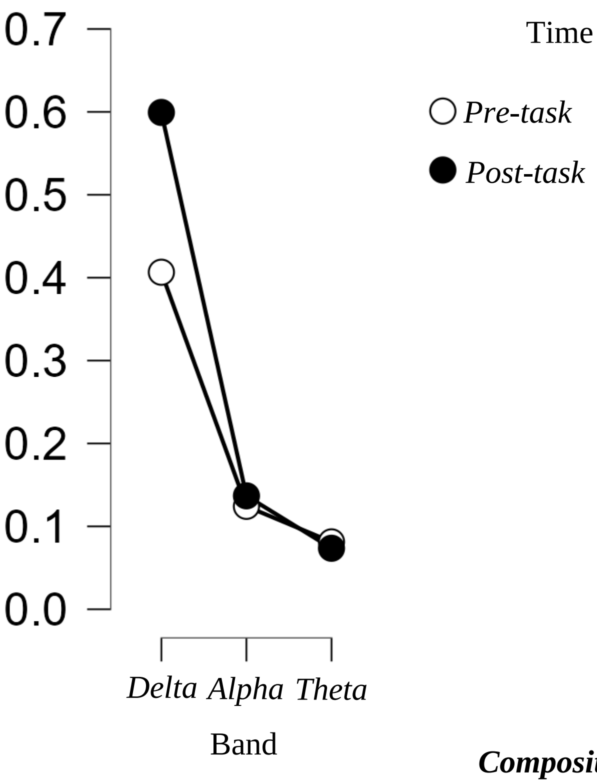
2. EEG Data

The significant effects found in EEG analysis are displayed in Figure 2.

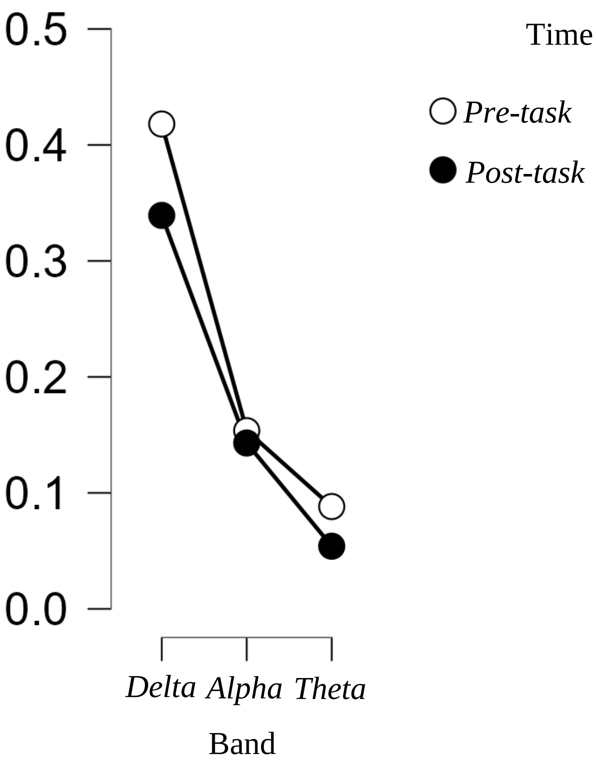
Figure 2

Main Effect of Band when comparing Alpha, Beta and Delta.

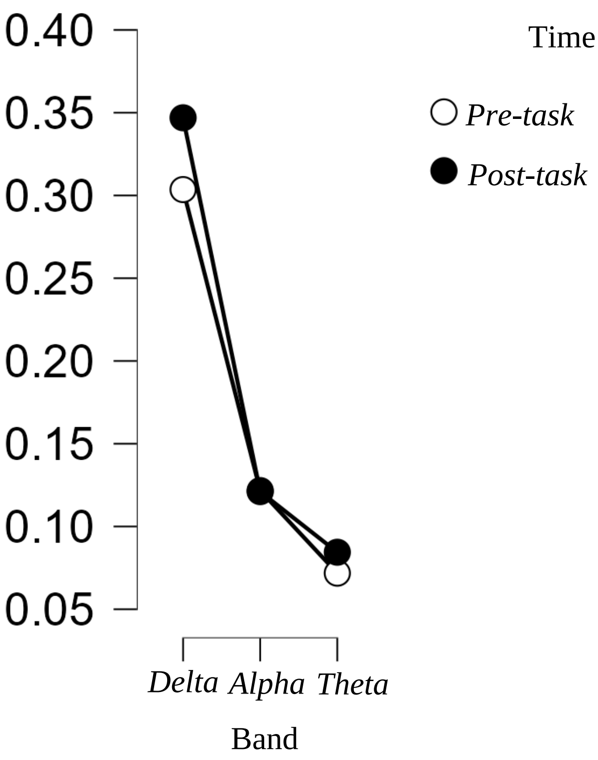
Exploration



Execution



Composition



The Music x Type of Activity x Time x Band repeated-measures ANOVA for the three bands highlighted in the literature as critical markers of wellbeing (alpha, beta, delta) showed only a main effect of Band, $F(1.22,42.61) = 17.51$, $p < .001$, $\eta_p^2 = .33$. Post hoc Holm tests showed that there were no significant differences between *Alpha* and *Beta* ($p = .33$), but that *Delta* ($M = 0.40$, $SE = .13$) had increased power than *Alpha* ($M = 0.13$, $SE = .095$, $p < .001$, $d = .375$) and *Beta* ($M = 0.076$, $SE = .063$, $p < .001$, $d = .456$). The absence of significant effects of Time or its interactions with other factors left us no evidence that the activities elicited changes in brain frequencies.

We also ran a second ANOVA with all five bands as levels, to see if different effects would emerge. However, all effects, including Band effects, were non-significant (*ps* > .111).

Discussion

In the current exploratory study, our goal was to investigate potential differences between distinct kinds of music practice regarding the effect they could have on wellbeing (Unconcern, Competence, Openness and Confidence) and humor (Joy, Excitement, Agitation, and Focus). To ensure that these musical practices had a beneficial effect, we compared them with analog non-musical activities. We examined both behavioral and EEG task-related changes.

1. Behavioral Data

After analyzing the structure of behavioral data (eight dependent variables), we ended up with six constructs – Productivity Factor (composed of Confidence, Competence, and Agitation), Unconcern, Joy, Excitement, Openness, and Focus. Unconcern showed no effects from Music or Type of Activity. All the other five variables demonstrated a beneficial effect of musical activities compared to their non-musical analogs. These findings indicate that music positively impacts wellbeing and humor. This is in line with Croom (2015), who claims that music practice can positively contribute to greater psychological wellbeing and a more flourishing life, as it can positively influence all five of the PERMA factors – positively influence emotions, engagement or flow experiences, interpersonal relationships, the experience of meaning or purpose in life, and contribute to the sense of accomplishment. This main effect was the only effect found in two of the five constructs – Joy and Excitement.

We also found a main effect of Type of Activity on three out of the five dependent variables – Productivity, Openness, and Focus. In all of them, *Execution* was reported to cause more wellbeing and humor than *Exploration*, and the same went for *Composition*, reported as causing more wellbeing and humor than *Exploration*. Thus, it seems that activities based on exploring and improvising freely, regardless of the presence or absence of music, generate less wellbeing and positive humor than activities based on composing/creating and executing/performing in any way. Focus was, from the other two, the only one to show significant differences between execution and composition, and these pointed to an increased positive effect of execution.

An interaction between Music and Type of Activity appeared for two variables – Productivity and Focus. In these cases, only *Composition* benefited from Music, while *Execution* and *Exploration* did not. When comparing only non-musical tasks, *Execution* outperformed both *Composition* and *Exploration* in boosting positive affective states. In contrast, when considering comparisons only among *Musical* tasks – the critical ones for us – *Composition* and *Execution* were more efficient than *Exploration*. In both cases (Music and Non-Music), Exploration elicited the poorest outcomes.

Since, to our knowledge, comparisons among the three types of activities we examined regarding wellbeing and humor are absent in the literature (except, partly, for Lopata et al. study), we have no term for comparison. However, one possible explanation of our findings is that Musical Exploration was hampered by the material and laboratorial circumstances, namely by participants being asked to play an unknown instrument while being observed. On the contrary, and according to our findings, Musical Composition can be a fun experience, and can make people feel more comfortable. This may relate to the fact that work can be done following guidelines, and that an output is obtained. According to our impression, participants seemed happy about their achievements, regarding both the process and the output.

Focus was an exception for the general advantage of Musical Composition over the other musical tasks. This is consistent with the idea that Execution requires higher levels of focused attention, regarding what the experimenter has just done and participants' self-monitoring during performance.

2. EEG Data

Unlike behavioral data, EEG data did not show significant task-related changes. The only significant result was a main effect of Band when comparing alpha, beta, and delta. Literature showed that the balance between these bands is likely to mark wellbeing and humor. We expected both alpha and delta to increase after the tasks, and beta to decrease. Results only showed the dominance of delta power in participants' spectrum in comparison to alpha and beta. Since delta waves are associated with profound meditation, we may speculate that participants were too exhausted/sleepy during the recording periods, which could be caused by the fact that they were sitting and just looking to a cross in a small confined room, in silence (some of them really seemed tired). Critically, the spectrum showed no changes after the task was completed in any task: there was no evidence that participants got more relaxed (alpha did not increase), nor that they increased focus and mental activation (beta did not increase). In addition, the pattern we saw does not match the one expected for a positive affect state, where both delta and alpha should show more power than beta.

Several potential explanations exist for the absence of task-related changes in the EEG. First of all, we had a short resting period, which we chose to minimize the length of the experiment. Though some studies also used two minutes, the literature generally recommends around four minutes. Also, given the exploratory nature of this study, we analyzed power collapsed across the whole scalp and did not use regions of interest. Thus, we might have missed local effects. Another limitation regards the possibility that the resting state period, when EEG was recorded and analyzed, contained a non-stabilized initial period, which we should have maybe excluded from the analysis. One final limitation may lie in the fact that, since the experimenter remained in the room with participants during tasks (to provide instructions), participants may have felt observed or judged, i.e., not relaxed. This may have been critical in musical exploration, even though they provided favorable reports at the behavioral level.

3. Limitations and Further Research

The limitations of this study are largely related to its broad scope, combined with an exploratory nature, which did not facilitate a deeper examination of EEG data: as we mentioned above, we may have missed important information for not trimming epochs (excluding an onset time segment), not attending to topography, or for using a short recording period (two minutes). In addition, we also have doubts about whether the test circumstances were ideal since the investigator's presence in the room may have prevented participants from relaxing. Future studies could address these handicaps, namely by enlarging the resting period and removing the first second of these from preprocessing, and by analyzing topographically local effects. Regarding the recording circumstances, we suggest that future studies find a solution to avoid the presence of humans in the room (for instance, with instructions provided only by the computer) or even try recording in naturalistic settings with a portable EEG.

With respect to behavioral data, we found robust evidence that music has a positive effect on wellbeing and humor. All measures except Unconcern showed benefits of music compared to its non-musical analogs. The insensitivity of Unconcern to the activities may reflect the difficulty participants might be having in relaxing (see above). Regarding Agitation, we found an unexpected pattern of increase, since the opposite (calm) was the one expected in a context of humor enhancement. However, our results seem to make sense in light of the proposed Productivity factor, which could also be associated with Focus and would make sense on the rationale we argued. For Productivity, as well as for Focus, Musical Composition was more effective than Non-Musical Composition and Musical Exploration. For Focus, Musical Execution was also more efficient when compared with Musical Composition (see above for one reasonable explanation). However simple and basic, creating a musical piece may be something empowering, in the sense that it may make us feel more confident, energized and with a greater sense of our competencies. Considering that Focus also benefitted from Composition to some extent, it seems reasonable to claim that musical creation is probably the best tool among the three music activities when it comes to enhancing wellbeing and positive humor in the short term.

Conclusion

Our study was novel in examining the affective benefits of different types of music practice. Musical composition emerged as a potentially vital tool to enhance wellbeing and humor. In contrast to the emphasis given to musical exploration in music therapy, our findings suggested that this may not be the best option for boosting positive affect. Besides its contribution to a better comprehension of how music-making brings affective regulation, our study provided clues to improve therapeutic approaches using music as a tool.

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