Nadja Catarina Gonçalves

THE CONSCIOUSNESS OF MUSICAL IMPROVISATION:
A PSYCHO-PHENOMENOLOGICAL PERSPECTIVE

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Dissertação no âmbito do Mestrado Interuniversitário em Neuropsicologia Clínica e Experimental, orientada pelo Professor Doutor Óscar Filipe Coelho Neves Gonçalves e pelo Professor Doutor Bruno Cecílio de Sousa apresentada à Faculdade de Psicologia e Ciências da Educação da Universidade de Coimbra

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THE CONSCIOUSNESS OF MUSICAL IMPROVISATION:
A PSYCHO-PHENOMENOLOGICAL PERSPECTIVE

Nadja Catarina Faria Gonçalves

Thesis submitted for the Interuniversity Master in Clinical and Experimental Neuropsychology, supervised by Professor Óscar Filipe Coelho Neves Gonçalves and by Professor Bruno Cecílio de Sousa and presented to the Faculty of Psychology and Educational Sciences of University of Coimbra

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Resumo

Título: A consciência da improvisação musical: Uma perspetiva psico-fenomenológica
Palavras-chave: Improvisação Musical, Consciência, Inventário Fenomenológico da Consciência, Música Jazz, Expertise.

A improvisação musical é um elemento central na música jazz e um exemplo único de comportamento criativo. Este ato envolve a interação simultânea de múltiplos processos cognitivos e motores. Denota-se que a investigação neste ramo foca sobretudo em compreender e identificar as estruturas e mecanismos cerebrais envolvidos, através de uma perspetiva cognitiva e funcional (neurociência). No entanto, é crucial incluir perspetivas como a psico-fenomenologia para compreender a qualidade subjetiva do que é experienciar algo. Nos estudos psico-femenologicos da improvisação são implementadas abordagens qualitativas. No entanto, enquanto estas adotam um método de estudo de caso, com validade externa limitada, o presente estudo procura estudar a estrutura e configuração do estado de consciência durante a improvisação, utilizando paradigma experimental baseado em medidas quantitativas e padronizadas. Adicionalmente, pretendemos averiguar se esta configuração varia em função da expertise em improvisação. Para este fim, vinte músicos de jazz, com distintas formações musicais, preencheram o Inventário de Consciência Fenomenológica após realizarem uma tarefa de improvisação musical. Dados musicais demográficos foram também recolhidos. Os resultados mostraram durante a improvisação, os músicos reportaram estar absorvidos na tarefa, atentos a sua experiência interior e uma diminuição de sentimentos afetivos. Para além disso, reportaram que o seu modo de pensar era claro e racional e que não experienciaram alterações na sua perceção do mundo exterior. Por último, foi observado que a intensidade nas diferentes dimensões de consciência variou em função da expertise. Em particular, uma fluência grande de improvisação foi associada a uma maior atenção interior, absorção e diálogo interno, em comparação com grupos em níveis mais baixos de expertise. As implicações destes resultados são discutidas brevemente.

Abstract

Title: The consciousness of musical improvisation: A psycho-phenomenological perspective
Keywords: Music Improvisation, Consciousness, Phenomenology of Consciousness Inventory, Jazz Music, Expertise

Musical improvisation is a prime example of creative behavior and a central element in the musical expression of jazz musicians. This activity is characterized by the complex interplay of cognitive and motor processes unfolding simultaneously. Cognitive neuroscience has attempted to infer from neural activity the conscious experience of the improvisational state of mind. However, to truly understand what is like to have a certain subjective experience, a psycho-phenomenological perspective is needed. Indeed, qualitative investigations have partaken in this enterprise, but while these adopt a case-study approach, with limited external validity, the present dissertation aimed to study improvisation's structure and configuration of consciousness using a reproducible experimental paradigm based on quantitative and standardized measures. Furthermore, we aimed to understand if this configuration of consciousness would vary as a function of improvisational expertise. Twenty jazz musicians, with different musical backgrounds and experience, completed the Phenomenological Consciousness Inventory after performing a music improvisational task. Musical demographic data was also collected. Results showed that musical improvisation was characterized by increased inward attention, absorption on the task, a decrease in affective processes, and an overall clear and rational way of thought toward the external environment. Finally, results showed that the intensity of these dimensions of consciousness varied as a function of expertise. In particular, high expertise was linked with higher inward attention, absorption, and internal dialogue compared to low levels of improvisational fluency. The implications of these results are discussed briefly.

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Table of Contents

Index of figures

Index of Tables

Introduction

Musical improvisation is one of the most cognitively intricate and creative human behaviors to date. This act is a central figure in the expression of jazz music. As put by Miles Davis, “I’ll play it first and tell you what it’s called later”. This renowned jazz instrumentalist was known for his skill in improvisation, from live performances to the composition of movie soundtracks, the latter written by just visualizing the movie and subsequently following musical spontaneity and intuition. These “stunts” cannot leave one unimpressed, and not least interested in investigating the underlying properties that play a part in this improvisational experience. Several studies have been conducted in the field of neuroscience and neuropsychology regarding this phenomenon (Biasutti & Frezza, 2015). However, in Pekala’s words (1991a, p. 2), “although consciousness is grounded in the brain and its neurophysiology, this does not mean that it is completely reducible to that level of analysis”. In other words, to truly understand the properties of consciousness, one should investigate what is like to have a given subjective experience. Thus, researchers are increasingly drawn to psycho-phenomenological approaches (Vroegh, 2019; Seth, 2021). As argued in latter sections, the present dissertation presents a relevant contribution to music cognition and consciousness research by investigating, from a psycho-phenomenological perspective, the properties of conscious experience during the act of musical improvisation.

In the next sections, I will go into more detail on the (i) conception of musical improvisation and its role in jazz music, (ii) the cognitive models and neural correlates of improvisation, and (iii) the study of phenomenology in psychology and the Phenomenological Consciousness Inventory (PCI). These sub-sections will explain the key principles presented in this dissertation, culminating in the presentation of the present goals and hypothesis.

Improvisation and Jazz music

Throughout human history, improvisation has been at the center of musical expression in all musical traditions. With the goal of creating unique musical compositions, this form of performance art requires the spontaneous expression of creative behavior, involving the simultaneous planning and execution of several processes unfolding at different timescales (Pressing, 1988). This creative behavior can be challenging, since, to improvise, a musician must master complex motor movements, required to play specific notes, while simultaneously producing and assessing the musical composition and coordinating his performance with other musicians. Moreover, this act depends on the musical knowledge of

the musician, and on how he decides to express such information (Beaty, 2015). Nonetheless, improvisation has been correlated with the state of flow (Habe & Biasutti, 2023). Flow can be defined as an optimal experience, where there's a balance between the challenge of the task and the skills of the participant (Csikszentmihalyi, 1990). When experiencing flow, during improvisation, musicians describe it as an exceptional performance, where the focus of attention is completely allocated to the task while experiencing a deep absorption and pleasure in the task at hand (Forbes, 2021; Habe & Biasutti, 2023). This state brings several positive aspects to improvisation, such as an increase in spontaneity, enjoyment, concentration, and control. Therefore, the implementation of music learning strategies and programs that promote flow, can prove to be very effective in the education of young musicians (Habe & Biasutti, 2023).

Musical improvisation requires a lot of skill and training in the context of professional musical performance. However, the ability to engage in creative actions and to improvise is something that is present in our day-to-day activities. With this we can say that non-musician individuals are capable of conducting improvisatory processes, in contexts of basic musical expression, such as in clinical settings (MacDonald & Wilson, 2014). The benefits of the use of therapy that incorporates elements of musical improvisation have reported changes in patients with mental disorders (anxiety and depression), by reducing symptomatology such as tension, anxiety, stress, feelings of guilt, and anguish, and help patients maintain a positive sense of self (Zarate, 2012; Park et al., 2023). Furthermore, benefits of these procedures have been demonstrated as well in group clinical settings regarding communication difficulties presented by children in the autism spectrum and with attention deficit hyperactivity disorder (MacDonald & Wilson, 2014).

Jazz, in particular, is where improvisation - as a skill and a performative process - has found its biggest spotlight since the genre itself has been historically built around it (Norgaard, 2011). Contrasting with other musical genres (namely the classical genre), jazz compositions serve mainly as a framework for soloists and/or a group of musicians to improvise on. Notwithstanding, the experience of flow seems to be considered a necessary competence for jazz improvisers (Habe & Biasutti, 2023). This, adding to the fact that it's in the jazz genre that we can find the source of the largest number of contemporary improvisers, is why populations in studies regarding music improvisation are usually comprised of jazz musicians.

Cognitive models of improvisation and neural correlates

Various cognitive models have been developed by researchers to explain the complexities of musical improvisation. In general, these models view improvisation as a complex cognitive act that involves: generative mechanisms, for the selection and generation of a musical repertoire; anticipation of music elements; flow; and feedback processes, crucial for decision-making (Csikszentmihalyi, 1990; Pressing, 2001; Johnson-Laird, 2002; Kenny & Gellrich, 2002). Pressing's model is one of the most influential models of musical improvisation, which continues to be the foundation for the study of this phenomenon in psychology and cognitive neuroscience. Pressing defines improvisation as a collection of generative and evaluative processes that involve some degree of conscious monitoring and cognitive control, with an even more significant role for automated motor functions and routines (Pressing, 2001; Beaty, 2015). According to Pressing, the improvisational act is enabled by the interplay between structures (i.e., procedural, and declarative information that are stored in long-term memory) and referent processes (i.e., the sum of retrieval cues used by the musician to guide performance and reduce cognitive efforts). Perceptual feedback and error correction also play a role in this process, allowing the improviser to monitor their performance and make adjustments accordingly. For Pressing, to achieve expertise or improvisation fluency it is needed a considerable amount of training, which will allow an automatization of processing that requires minimal conscious attention (Pressing, 2001; Dean & Bailes, 2014; Beaty, 2015).

In parallel, research on the neural correlates of musical improvisation has revealed that improvisation targets various brain regions related to motor function, attention, executive control, emotional processing, sensory function, and language. Improvisational expertise has been found to modulate the activity in these areas (Beaty, 2015; Erkkinen & Berkowitz, 2019). The neuroimaging and electrophysiological studies have identified specific brain regions linked with improvisation. Areas of the prefrontal cortex (PFC), namely the dorsolateral prefrontal cortex (DLPFC) - which plays a critical role in modulating top-down processes and executive functions - exhibited different types of activation depending on the task. Decreased activation of this area is associated with the suppression of top-down processes such as goal-directed, self-monitoring, executive processing, and motor planning (Erkkinen & Berkowitz, 2019). This pattern of deactivation was found to be an indicator of improvisational expertise (Pinho et al., 2015; Rosen et al., 2020) and higher levels of creativity (Limb & Braun, 2008; Erkkinen & Berkowitz, 2019). However, the opposite pattern, of activation, was observed in areas that control internally motivated behaviors: the

medial prefrontal cortex (MPFC; Limb & Braun, 2008). Fine motor movements are required for improvisation, which is observed by activation in all motor regions and by increased functional connectivity with prefrontal areas. Once more, the connection between these regions seems to be modulated by expertise, as improvisers with more training showed a stronger connection between motor areas and a variety of other networks involved in improvisation (Liu et al., 2012; Pinho et al., 2014; Beaty, 2015). These findings support Pressing's ideas, regarding the role of expertise on the demands of the task, meaning that as improvisational fluency increases, cognitive demands decrease.

Regarding emotional processing, limbic areas such as the amygdala and insula showed increased functional connectivity with prefrontal areas. A deactivation of these areas may indicate the presence of positive affective process (Liu et al., 2012; Erkkinen & Berkowitz, 2019). Activation on language areas such as the left inferior frontal gyrus (IFG) is thought to play a role in the configuration of motor movements, the recognition of different elements in harmonies and rhythms, and the construction and structuring of musical compositions (Limb & Braun, 2008; De Manzano & Ullén, 2012; Erkkinen & Berkowitz, 2019). Sensory domains also tend to emerge in studies of improvisation, whether auditory (guiding musical ideas and recall), somatosensory (reflecting task demands), or visual processing (reflecting visual demands such as using a sheet of music) (Erkkinen & Berkowitz, 2019).

In summary, musical improvisation produces changes in brain regions involved in motor control, attention, emotional, linguistic, and sensory processing. We can see that many of the components of Pressing's cognitive model are reflected in neuroimaging studies of improvisation, revealing an intricate pattern of combinatory bottom-up and top-down processes. When a musician improvises, they generate an output (top-down) that receives feedback from bottom-up areas, allowing them to monitor and correct errors. Still, as predicted by Pressing, the exchange between these processes is mediated by improvisational fluency and training, in which through automatization, top-down processes are usually suppressed, reducing cognitive efforts, and enabling the participant to focus on their subjective experience.

Phenomenology and the Phenomenological Consciousness Inventory

Consciousness is a complex phenomenon, that requires the input of several research fields to understand it. In recent years, with the development of neuroimaging techniques and with the aim to map complex states of consciousness in the brain, various research has been

conducted with regard to the neural correlates of consciousness. However, to truly understand "what it's like" to have a specific subjective experience, and what are the contents of that experience, one needs to turn to other areas of research such as phenomenology. Phenomenology in psychology can be defined as the exploration of consciousness through the study and observation of the subjective experiences of the individual (Pekala, 1991; Seth, 2021). This area of study provides the basic information on a specific state, that can serve as a basis for the areas of functional, neuronal, and behavioral sciences. Together, these areas aim to identify the properties and cognitive functions involved in the construction of conscious experiences (Pekala, 1991; Pokropski, 2019). There are very few studies that use a psycho-phenomenological approach to explore musical improvisation, and usually rely on qualitative analysis, and interviews to understand the subjective experience of the musician (Norgaard, 2011; Forbes, 2021).

The Phenomenological Consciousness Inventory (PCI) is a self-report questionnaire that maps the structure and organization of consciousness in different states of consciousness. This quantitative measure contributes to the study of psyco-phenomenological aspects of consciousness empirically, providing the researcher with a tool that statistically evaluates changes in the subjective experiences of several individuals in response to different stimulus conditions (Pekala, 1991b). The PCI was developed from the (Abbreviated) Dimensions of Consciousness Questionnaire ((A)DCQ; Pekala et al., 1986), with the implementation of the four primary emotions: anger, fear, sadness, and joy. The PCI measures 12 major dimensions and 14 minor dimensions of consciousness, including Altered Experience, Positive and Negative affect, Attention, Imagery, Self-awareness, Internal Dialogue, Awareness, Rationality, Memory, Arousal, and Volitional Control. The instrument presents good internal consistency and good discriminant validity. Results on cluster analysis presented in the original study (Pekala, 1991b), revealed that the dimensions of the PCI remain the same throughout different conditions, regardless of changes in their intensity. This questionnaire is typically used to measure altered states of consciousness such as meditation and hypnosis. However, recent studies have implemented it to study other complex conscious states, such as absorption in music listening, and altered states induced by drugs (Vroegh, 2019; Ramaekers et al., 2023).

The goals and hypotheses of the present dissertation

The present study aims to characterize the subjective experience of jazz musicians while improvising, using a quantitative approach (PCI), something that to our knowledge no other study has attempted before. Based on the existing cognitive, neural, and

phenomenological models of improvisation, we hypothesize that musical improvisation will be associated with alterations in the dimensions of Time sense, Positive affect, Attention, Self-awareness, Rationality and Internal dialogue. Specifically, we expect that improvisation will be linked to alterations in the perception of time, that attention will be mainly focused on their internal subjective experience, and that high levels of absorption on the task will be observed. Furthermore, we expect that feelings of joy and love will be present and that the musician's way of thought will be clear and rational. Lastly, we expect to observe a loss of self-awareness and an increase in internal dialogue. Additionally, we propose that the configuration of these dimensions will change as a function of musical expertise, where participants with higher improvisational fluency will have higher scores on the dimensions of Time sense, Positive Affect, Attention, Internal Dialogue, and low values on Self-awareness. With this study, we hope to help fill in the gap regarding the understanding of the psycho-phenomenological properties of consciousness during improvisation.

Studying improvisation is relevant to the areas of psychology of music, creativity, and cognitive neuroscience. Understanding the nature of improvisation and creativity can decipher the cross-domain processes that underlie creative cognition, and shed light on basic cognitive neuroscience, as it offers unique insights into how learned expertise shapes the structure and function of the brain (Beaty, 2015). Therefore, studying the subjective experience of improvisation can provide insights into several topics such as creativity, personality construction, flow experience, and improvisational thinking. Overall, these studies contribute to advances in music education, and music therapy.

Method

Participants

Data was collected from 20 healthy participants (1 female), with ages ranging between 18 and 52 (M = 26.20, SD = 9.21). The sample was comprised of professional jazz musicians, jazz professors, and graduate and undergraduate music students from the School of Music and Performing Arts of Porto (ESMAE), Lisbon School of Music (ESML), Luiz Villas-Boas Jazz School (Hot Clube of Portugal), and Braga Jazz School (EBJ). All participants were in good health and had normal or corrected-to-normal vision and hearing. The inclusion criteria for participation in the experimental task were (i) the ability to improvise to novel chord progressions in jazz notation, and (ii) having basic, intermediate, or

advanced jazz improvisation skills on the following instruments: guitar, piano, trumpet, saxophone, trombone, clarinet, violin, flute, vibraphone or singing.

Participation was voluntary and no monetary compensation was provided. All participants signed an informed consent form. The study was conducted under the ethical standards approved by the Faculty of Psychology and Educational Sciences of the University of Coimbra (FPCE-UC) research ethics and deontology committee and the code of ethics of the World Medical Association (Declaration of Helsinki).

Experimental task

A within-subjects design was used in which participants individually completed a musical improvisation task and subsequently responded to the Phenomenological Consciousness Inventory adapted for the Portuguese population (Martín & Ángeles, 2014). Also, a musical demographic questionnaire was administered prior to the experiment.

Musical improvisation task. In this task, participants were instructed to improvise for 5 minutes to one chord progression displayed on a monitor and accompanied by a backing track. There were 4 possible chord progressions, and one was selected at random for each participant. The chord sequences were composed by a professional jazz musician for the present study (see Figure 1 for an example; see Annex A for the complete array of chord sequences), taking inspiration from the chord sequences used by Rosen and colleagues (2020) (see Figure 2 for an example). The goal was to create distinctive 16-bar sequences of equal duration, difficulty, and tempo that incorporated familiar jazz patterns. The decision to use new chord sequences in the present study was made to capture more authentic improvisations than previous studies, which typically used chord sequences from jazz standards, and thus didn't control for prior knowledge and familiarity with the stimuli.

Phenomenological Consciousness Inventory. The PCI is a quantitative self-report measure used to assess the subjective experience of an individual after a specific task/stimulus condition. In the present study, it was used in full to measure the subjective experience of jazz musicians after being in a state of improvisation (see Annex B for the full instrument). This instrument has in total 53 items. Each item is composed of two extreme affirmations divided by a seven-point Likert scale, that ranges from 0 (none or little) to 6 (completely). For each item, the participant rates the extent to which each affirmation reflects their subjective experience regarding a specific stimulus condition. This instrument assesses 12 major dimensions and 14 associated (sub)dimensions of consciousness: (i) positive affect (sexual excitement, joy, love), (ii) altered experience (time sense, body image, perception,

meaning), (iii) negative affect (anger, fear, sadness), (iv) visual mental imagery (vividness, amount), (v) attention (absorption, direction), (vi) self-awareness, (vii) internal dialogue, (viii) altered awareness, (ix) rationality, (x) volitional control, (xi) arousal (decreased relation), and (xii) memory.

Figure 1.

Chord progression number 4 presented in the musical improvisation task

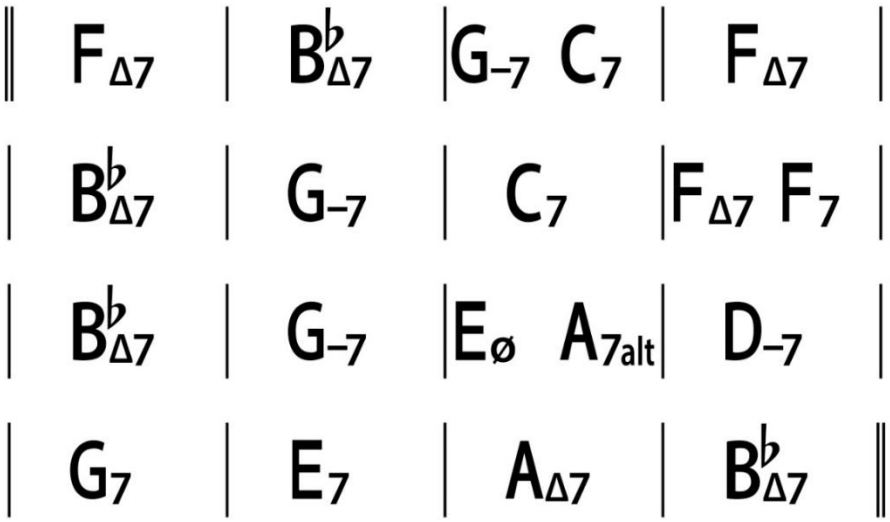
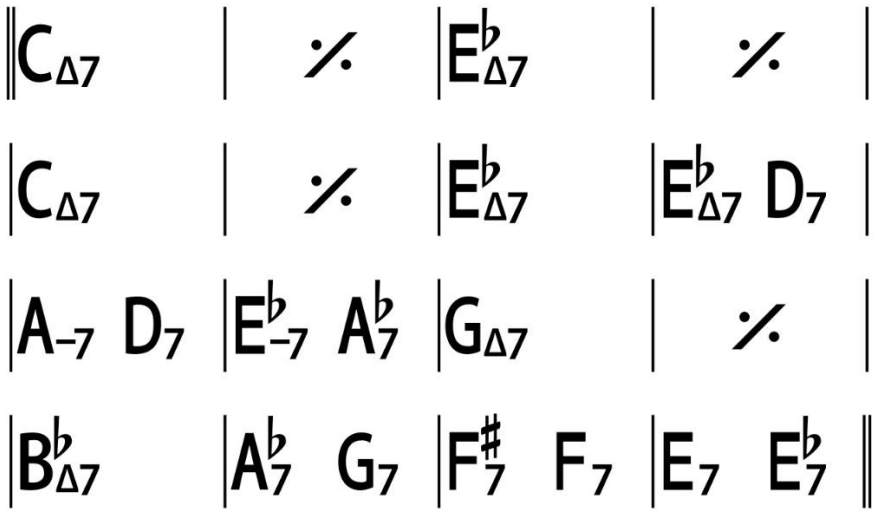


Figure 2.

Example of a chord sequence that inspired the ones created for the musical improvisation task.



Note. Source. Rosen et al. (2020)

Musical Demographic Data. At the end of the experiment, participants filled out a standard demographic questionnaire, with additional questions aiming to characterize their musical background (see Annex C for the full questionnaire). The range of experience with improvisation varied from 1 to 42 years (M = 8.60, SD =10.04), whereas the years of overall musical training ranged from 6 to 42 years (M = 15.70, SD = 8.76). Instruments played were comprised of electric bass (N = 1), contrabass (N = 3), guitar (N = 6), piano (N = 2), saxophone (N = 2), trombone (N = 1), and trumpet (N = 3). Additional demographic information such as hours of improvisation practice per day and, number of musical live performances both in jazz and other styles were also collected (see Table 1).

Experimental setup. The task was programmed and presented in the music software iReal Pro version 10.12 (Technimo, New York, NY, USA), using a laptop computer with a 14 inches screen, and with backing tracks and auditory cues being delivered by a high-fidelity speaker (Soundcore Motion; Anker, Hunan, China). Participants played their instruments in front of the computer seated or standing, depending on the instrument played. A sound speaker was strategically placed in the room depending on the instrument played to create a familiar earing experience for the participant.

Table 1

Musical Demoghaphic data

	Minimum	Maximum	Median	Std. deviation
Years of musical training	6	42	16.22	9.09
Years of improvisational training	1	42	9.14	10.46
Hours of improvisational practice per day	0.50	8	2.74	2.36
Number of live jazz performances	1	1600	236.33	493.13
Number of live musical performances	10	2900	441.83	849.62

Procedure

The present project was submitted and approved by the Ethics Committee of the Faculty of Psychology and Educational Sciences of the University of Coimbra (FPCE-UC).

The experiment took place in different music schools, including ESMAE, ESML, Luiz Villas-Boas Jazz School (Hot Clube of Portugal), and EBJ. Participants provided their signed informed consent and underwent the following steps: (1) description of the entire procedure; (2) familiarization with the respective instrument and setting of audio parameters for the backing track; (3) a practice block with a chord progression different from that of the musical improvisation task; (4) experimental task was carried out without breaks; and (4) a musical and sociodemographic questionnaire. The extent of the procedure was around 25 minutes.

Statistical Analysis

Analysis was conducted using IBM SPSS statistics software (Version 27) in three steps. First, to observe if the results of the PCI dimensions were statistically significant, data from the original study, on the condition of eyes open was used (Pekala, 1991b). Wilcoxon tests were conducted for each major and minor dimension. Second, descriptive statistics were analyzed for the musical demographic data (Table 1). To estimate the expertise of the participants, the number of hours of improvisational practice was multiplied by years of improvisational practice. Empirical data has proved that proficiency increases in a logarithmic space (Newell & Rosenbloom, 1981). Therefore, the natural logarithmic transformation was applied to the measures of expertise and number of live jazz performances. Afterward, participants were divided into three categories: low (until the 30^{th} percentile), medium (from the 30^{th} until the 70^{th} percentile), and high (above the 70^{th} percentile) improvisational skill. To conduct an exploratory analysis, this categorization was also conducted for the categories of total hours of improvisation practice per day, years of improvisation, years of musical practice, and number of concerts in all genres. Lastly, Kruskal-Wallis test was conducted to see if differences were found in the dimensions of the PCI results considering the levels stipulated for improvisational skill.

Results

PCI data

Reliability and Internal consistency. Reliability analysis was conducted for the five pairs of duplicate items. The Reliability Index (RI) was calculated for all participants by subtracting the scores of the two items of the item-pair duplicates. Excluding the two participants who presented an RI score bigger than 2.0, the average reliability index was .90 and ranged from .20 to 1.40. Regarding internal consistency of the (sub)dimensions, Cronbach's alpha ranged from a low of .47 on volitional control to a high of .99 on sexual

excitement. The average Cronbach's alpha was .77. The dimension of love presented a negative Cronbach alpha. Since this is a subdimension of positive affect, both were taken out of the analysis (see Table 2). These results support a good reliability of the PCI major and minor dimensions.

Table 2

Internal consistency of the Dimensions of the PCI

Dimensions	Alfa de Cronbach
Altered Experience	.81
Unusual Meanings	.80
Body image	.49
Time sense	.83
Perception	.67
Positive affect	.50
Joy	.84
Sexual excitement	.99
Love	-.25
Negative affect	.86
Anger	.64
Sadness	.94
Fear	.87
Attention	.78
Direction	.63
Absorption	.90
Imagery	.77
Amount	.86
Vividness	.66
Self-awareness	.75
Altered state of awareness	.85
Internal dialogue	.95
Rationality	.60
Volitional control	.47
Memory	.77
Arousal	.82

Intensity of PCI dimensions. Intensity scores were calculated for each (sub) dimension of PCI, and non-parametric tests (Wilcoxon) were conducted to observe differences between them and standard values (Pekala, 1991b). These revealed that the major and minor dimensions of Altered Perception, Sexual excitement, Sadness, Fear, Attention (Direction, Absorption), Imagery (Amount, Vividness), and Rationality showed significant

differences ($p < .10$), from baseline values. This analysis was conducted twice, to see if major differences would be found with the exclusion of the two participants that presented a score higher than 2.0. Since some differences were found, these two participants were taken out of the remaining analysis. To see the results in more detail, see Table 3.

Table 3

Results of Wilcoxon tests conducted for each dimension of the PCI.

Dimensions	Test Value	Observed value	Test statistic (W)	*p*-value
Altered Experience	2.07	2.19	90.00	.85
Unusual Meanings	1.71	1.50	90.00	.84
Body image	2.70	2.33	55.00	.18
Time sense	2.61	3.17	123.00	.10
Perception	1.40	0.50	39.00	.04**
Joy	2.68	3.00	98.00	.58
Sexual excitement	2.26	0.00	23.00	.005**
Negative affect	1.24	0.33	54.00	.16
Anger	1.22	0.00	96.00	.64
Sadness	1.64	0.25	39.00	.04**
Fear	0.86	0.00	36.00	.02**
Attention	3.71	4.80	149.00	.006**
Direction	3.80	4.67	158.00	.002**
Absorption	3.58	5.00	128.00	.06*
Imagery	3.78	1.50	2.00	< 0.001
Amount	3.67	0.75	12.00	<0.001
Vividness	3.89	1.50	1.00	<0.001
Self-awareness	4.20	3.83	54.00	.17
Altered state of awareness	2.17	2.17	105.00	.95
Arousal	1.81	1.75	78.00	.74
Rationality	4.21	3.50	40.00	.047*
Volitional control	3.95	3.67	60.00	.26
Memory	4.25	4.00	58.00	.23
Internal dialogue	4.10	4.50	81.00	.84

Note. This table represents the results of the Wilcoxon test, comparing the normative values of the sample to the observed values in our sample, for each dimension of the PCI. W refers to the test statistics.
* $p < .10$; ** $p < .05$

Relationship between PCI scores and musical background

Improvisational expertise. To test whether the intensity scores of the PCI (sub)dimensions varied according to improvisational expertise, participants were divided into three categories low, medium, and high improvisational skill. Since normality standards were not met, Kruskal-Wallis tests were conducted to observe possible differences between the three groups. Results showed significant differences between groups ($p < .05$) in the dimensions of altered perception, sexual excitement, attention, absorption, and internal dialogue. Separate analyses were conducted between each pair of groups. Statistical differences were found in Internal Dialogue in all three pairs of groups. Attention and Absorption were found in the groups of high and low and medium and high. Differences for Sexual Excitement were only found between the low and medium group, and for meaning between the group in low and high.

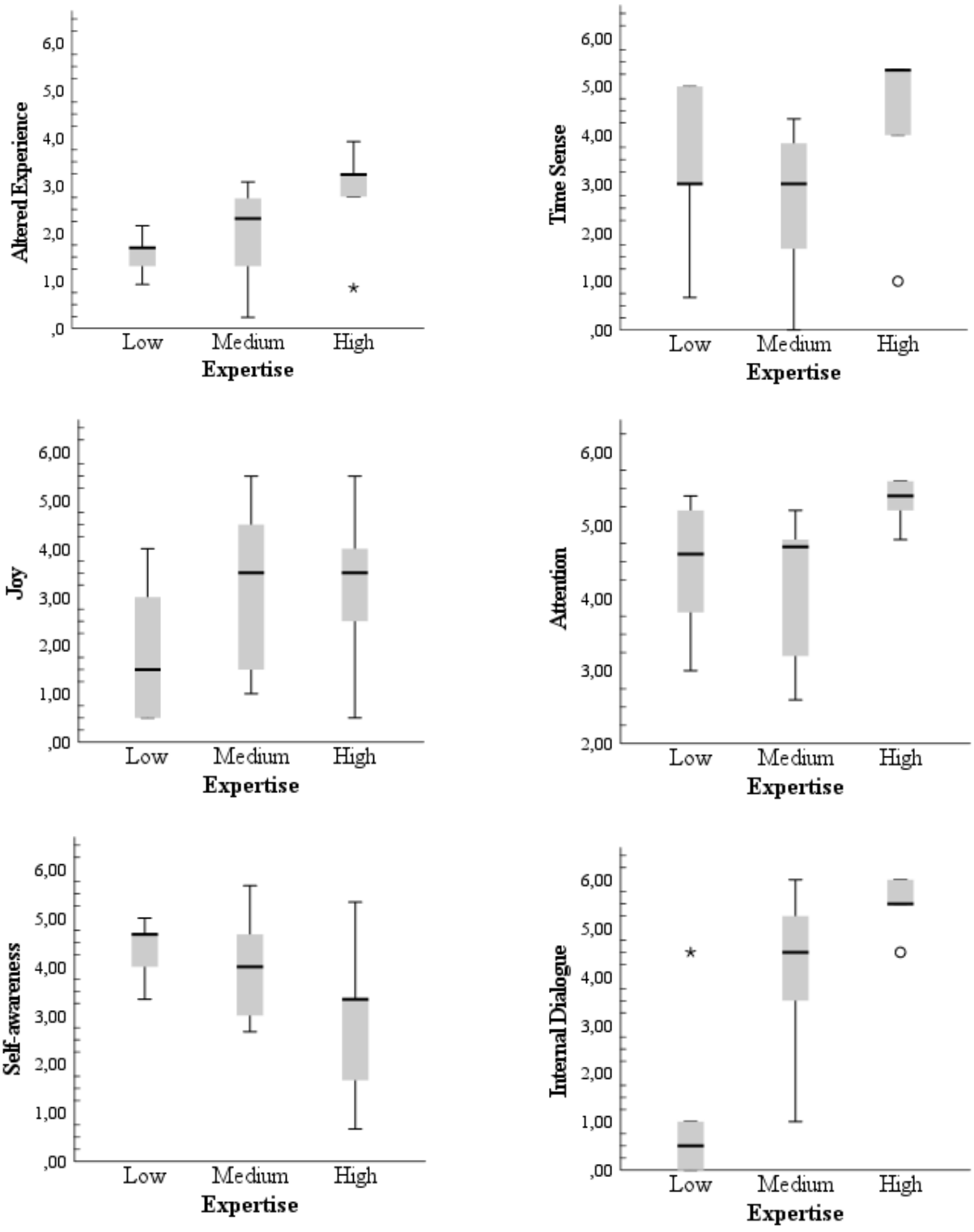
Graphical representation of these results shows tendencies in scoring that are not statistically different. This is the case for the dimension of Altered Experience, which presents an increase in scores from low expertise (M = 1.69, SD = 0.46) to high expertise (M =3.23, SD = 1.16). This pattern is furthermore present in some of its subdimensions (Time Sense, Altered Perception, and Unusual Meaning). In specific the dimension of Time sense presented overall high scores, with higher levels of expertise scoring higher compared to low levels. On the other hand, the dimension of Self-awareness presents a decrease in scores from low expertise (M = 4.67, SD =0.67), to high expertise (M = 3.83, SD =1.30). Last, the dimensions of Joy presented higher scores for the middle and high expertise groups (see Figure 3).

Number of live jazz performances. Regarding the number of live jazz performances, participants were again distributed between three groups, from lower number of performances to higher number of performances. Kruskal-Wallis test revealed significant differences in the dimensions of Body Image and Imagery Amount. These differences were found when conducting separate analyses between the groups of low and high performance and low and medium. Furthermore, observation of the boxplots showed the same patterns of

an increase in the dimensions of Altered Experience, Time Sense, Perception, Unusual Meaning, Joy, Absorption, and a decrease in Self-awareness.

Figure 3.

Graphical representations of the differences in intensity scores of relevant PCI dimensions, between the different groups of improvisational expertise.



Note. Here I present the differences between the groups of low, medium, and high expertise on the dimensions (from left to right) of Altered Experience ($p = .13$), Time sense ($p = .19$), Joy ($p = .35$), Attention ($p < .05$), Self-awareness ($p = .29$) and Internal dialogue ($p < .05$), in the form of Boxplot graphs.

Other musical background categories. Further analysis was conducted to test differences in the categories of number of practice improvisation hours, number of years engaging in improvisation, and years of musical experience. Participants were divided again into three different categories. Results on number of hours revealed significant differences in Altered Experience, Perception, Meaning, Self-awareness, and Internal Dialogue. Again, the dimensions of altered experience, perception, meaning and internal dialogue presented higher values for participants in the high expertise group, and lower values in the dimension of self-awareness. Analysis of the number of improvisational years and years of musical experience revealed no significant differences.

Discussion

In this study, we conducted a psycho-phenomenological investigation of subjective experience during musical improvisation. In particular, we analyzed how the contents of consciousness change during the act of improvisation, compared to resting state, and how much these changes are shaped as a function of improvisational expertise. This marks a novel approach to the study of music improvisation since it captures the phenomenological experience of improvisation using a quantitative and standardized measure – contrasting with conventional interview-based or shortened self-report scale approaches (Norgaard, 2011; Rosen et al., 2020) – while also sampling a wide array of jazz musicians with different backgrounds, instruments, and expertise levels. In addition, data collection was carried out in the participants' own music schools and rehearsal places, allowing for a more naturalistic observation of improvisation, compared to laboratory settings. Ultimately, our results show that several dimensions of consciousness are significantly altered during the act of improvisation, compared to ordinary resting state, but also that expertise level significantly affects the configuration of such changes.

Overall, our results showed that the musicians subjective experience while improvising was characterized by higher levels of attention directed inward (to the musician's subjective experiences), a complete absorption on act the of improvisation, no alterations on perception of the outside world, no visual imagery, a decrease in affective

experiences, and by a clear an rational way of thought. These findings support the idea that improvisation is a complex task that requires significant cognitive resources from the musicians. These cognitive demands, require the musician to be focused on the task at hand, and, therefore, no alterations in their perception of the outside world were found, nor in their capacity for rational and clear thought. As our results show, improvisation is an act that requires a high level of inward attention and absorption. This is observed in neuroimaging studies by a deactivation of the right temporoparietal junction (TPJ), which is reflected by a decrease in top-down control in tasks that demand inward attention, such as divergent thinking, creative thinking, and music improvisation (Beaty, 2015). Altogether, our findings characterize improvisation as a state of (i) increased inward attention and absorption on the task, (ii) a decrease in affective factors of positive and negative valence, (iii) a clear and rational way of thought and by (iv) no alterations in their perception of the outside world.

Another goal of this experiment was to see if the changes in the configuration of consciousness were a function of expertise, as observed in neuroimaging studies (Pinho et al., 2014; Erkkinen & Berkowitz, 2019). Indeed, we found significant differences on several dimensions between musicians with low, medium, and high expertise. In general, musicians with higher expertise experience some degree of alterations in their perception, and an increase in their internal dialogue. Furthermore, compared to groups in low and medium expertise, they direct their attention to their subjective experience and are absorbed on the task with increase intensity. Important to note that even though some degree of alterations in perception were observed within the higher expertise group, they were still within normal values. It is possible that this change happened because of their complete immersion on their internal subjective experience and on the task, rather than to actual alterations in their perception of the outside world (i.e., changes in color, shape or textures).

These results conform with Pressing's claims that musical training reduces the cognitive efforts of the improvisation act, by increasingly automatizing cognitive and motor processes, allowing musicians with higher levels of expertise to indulge in more fluid, spontaneous, and disinhibited attentional states during improvisation (Pressing, 2001). It is possible that the lack of musical repertoire and "referent process" (Pressing, 2001), that are acquired with training, makes novice musicians less absorbed in the task, due to the constraints of monitoring their performance. Indeed, this pattern of differences between different levels of improvisational expertise has been reported in neuroimaging studies. In particular, high expertise was correlated with a deactivation of the DFLPC and subsequent suppression of the top-down process, including goal-directed behavior and executive

processing. Nevertheless, other areas of the prefrontal cortex such as the MPFC, which controls internally motivated behaviors, reported higher activation during improvisation (Limb & Braun, 2008). This combination of patterns was observed as well in our results by the musicians experiencing higher levels of internal dialogue, inward attention and absorption on the task as a function of expertise.

Even though significant differences were not found on some dimensions of consciousness, we found some patterns of intensity that are worth exploring. The high expertise group demonstrated a decrease in the intensity of their self-awareness, and an increase in alterations on their perception of time passage, and on feelings of joy. In fact, all groups seam to experience some sense of alteration in their perception of time. As mentioned before, expertise has been correlated with the suppression of top-down processes that are involved in the regulation of self-monitoring processes such as self-awareness. Therefore, as our results show, highly expert musicians present a decrease in self-monitoring processes (Beaty, 2015). Notwithstanding, a decrease in activation in limbic areas may be associated with the affective positive experiences that occur while improvising (Limb & Braun, 2008). It is possible that the changes in positive affect that we observed, are correlated with these factors and that due to the cognitive efforts of the task, the presence of positive affect (specifically in feelings of joy) may be mediated by expertise.

These patterns are also observed in the state of Flow (Forbes, 2021). Flow is a state of mind that comprises cognitive, emotional, and physiological aspects, entailing a self-rewarding and optimal experience, where there is a balance between the challenge of the task and the skill of the individual. It is also characterized by immersion in the task at hand (attention), loss of self-consciousness, and distortion of time sense (Csikszentmihalyi, 1990). Flow has been reported as a crucial element in improvisation and is more likely to be experienced by skilled musicians, due to their musical practice (Forbes, 2021). Even though measures of Flow were not applied in our study, patterns that configure Flow states were found in our sample. In specific, high expertise was correlated with increased feelings of joy, absorption in the task, internal dialogue, alterations in time perception, and a decreased in self-consciousness presented by a decrease on the intensity of self-awareness.

Overall, our hypothesis that the dimensions of consciousness that characterize improvisation, would vary as a function of expertise was somewhat met. In specific, we expected that higher expertise would be characterized by an increase on alterations of time perception, inward attention, absorption on the task, intensity of positive affect and internal dialogue, and by a decrease on self-awareness. Regarding the dimension of positive affect,

our hypothesis was not able to be proved due to problems with the internal inconsistencies present in the sub-dimension of love, and therefore in its respective dimension of positive affect. Since, studies on neuronal aspects and flow in improvisation showed an increase in positive valenced affective processes (Limb & Braun, 2008; Forbes, 2021), future studies, with bigger samples should be conducted to better characterize the subjective experience of emotional processes during improvisation.

The total number of live jazz performances is sometimes used as a measure of a musician's experience. In this dissertation, however, the results were inconclusive, since not all participants that belong to a specific group in expertise belong to the same group in this category. Nonetheless, high expertise presented higher alterations in their body image perceptions, and on the amount of imagery experienced. Since no literature was found concerning this, it might be interesting for future studies to better comprehend the impact that live performances might have on the alteration of perception in these specific dimensions of consciousness.

Limitations and Future studies

This present study had a few limitations. First, due to the lack of volunteering, our sample size was smaller than expected, which had implications for the possibility of analysis conducted. The authors of the PCI advise that to get the full picture of the underlying structures and configuration of consciousness one should conduct the following analysis: factor analysis, cluster analysis, and creation of a psygram (Pekala, 1991). The psygram is a diagram that allows the visualization of the intensity of the different conscious dimensions on a specific condition, and their relationship and common variance with each other. With this tool, it would be possible to create a psychometric profile of the act of improvisation. Future studies should conduct this experiment with a bigger sample, eventually with the help of monetary compensation, to increase participation.

Second, a big constraint is the lack of diversity in gender, since our study only had one female participant. Pekala (1991b) in the original paper of the PCI showed that differences were found regarding gender on the (sub)dimensions of imagery (vividness imagery) and inward attention. In specific, women showed significantly higher values on these dimensions compared to men. It is possible that this difference might appear as well regarding improvisation. Therefore, the impacts of gender on the subjective experience during improvisation should be better studied since they might have implications in future research regarding improvisation, creativity, and even musical education.

Conclusion

In sum, we can conclude that the musician's consciousness, when improvising, is characterized by a clear and rational way of thought and by an increase in inward attention and absorption on the task. In addition, as predicted by Pressing's cognitive model of improvisation, this configuration varied according to the time spent training improvisation during their lifetime. In specific, musicians with a higher level of expertise were more likely to experience an increase in attention to their subjective experience, a higher absorption on the task, and higher internal dialogue, compared to lower levels of expertise. This configuration presented similarities to the state of flow, a characteristic that is thought to be key in the act of improvisation. Furthermore, other results suggested the presence of patterns of consciousness that are mediated by expertise, on other dimensions, such as alterations in the perception of time, self-awareness, and feelings of joy, whose further exploration should be pursued in future studies using a bigger sample to better characterize the underlying subjective experiences during improvisation. This study, contributed to the understanding of the musician's subjective experience while improvising, and provided results that corroborate the findings from neuroimaging and cognitive studies in this regard.

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Annex A

Chord progressions presented in the musical improvisational task.

Figure A1.

Chord progression number 1.

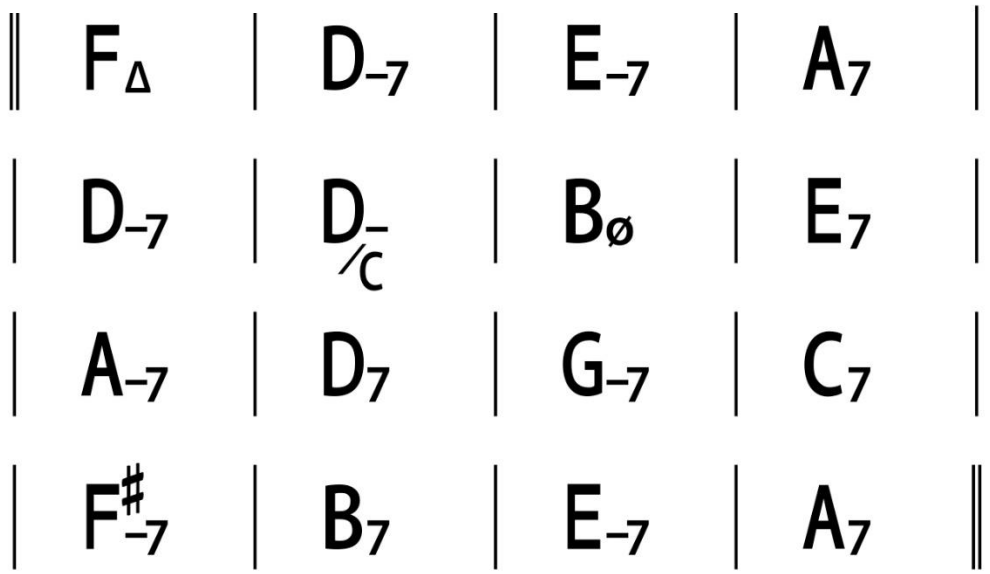


Figure A2.

Chord progression number 2.

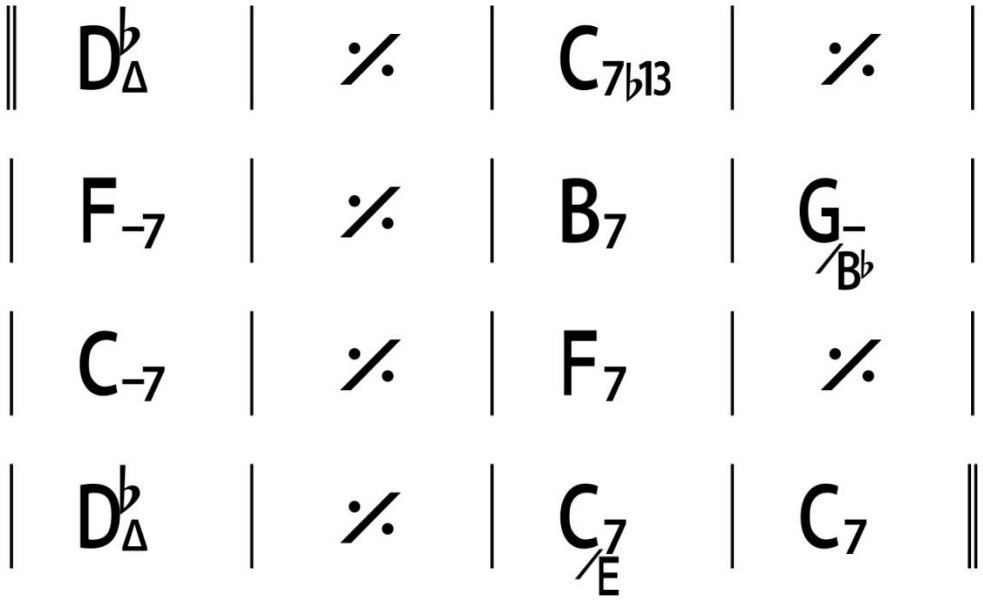
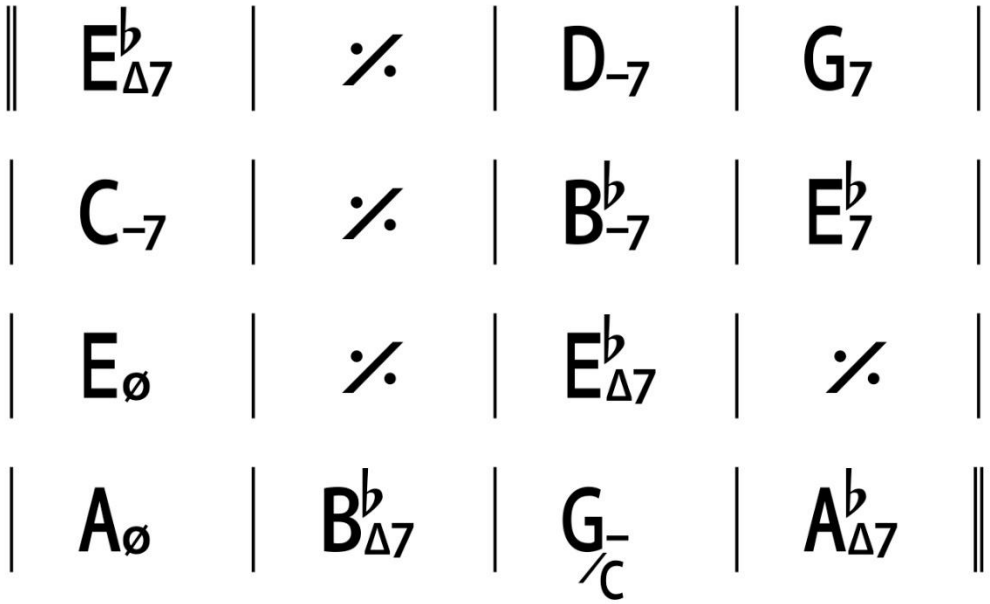


Figure A3.

Chord progression number 3



Annex B

The Phenomenological Consciousness Inventory for the Portuguese population
(Pekala, 1991; Martín, 2013)

Instruções

Neste questionário, iremos apresentar itens como o seguinte:

Senti-me muito tranquilo/a 0 1 2 3 4 5 6 *Senti-me muito ansioso/a*

Em cada item, rodeia o número entre "0" e "6" que melhor corresponde ao que sentiste durante o período em que estavas a improvisar.

Marcar o "0" significa que a tua experiência foi muito mais próxima da afirmação da esquerda (estavas "muito tranquilo"), e marcar o "6" significa que a tua experiência foi muito mais próxima da afirmação da direita (estavas "muito ansioso"). Por outro lado, se não estivesse nem "muito tranquilo" nem "muito ansioso", ou te sentisses entre os dois estados, marcarias a resposta "3".

Marcar os números entre o "0" e o "6", significa que a sua experiência esteve entre a esquerda e a direita. Por favor, sinta-se livre para selecionar qualquer um dos números entre "0" e "6".

Para melhor avaliares o que sentiste, proporcionamos-te as definições de algumas palavras-chave utilizadas neste questionário (ver coluna à direita)

Lê cuidadosamente os itens que se seguem e responde rodeando o número entre "0" e "6" que melhor corresponde ao que sentiste enquanto improvisavas. Faz o mesmo para todos os itens.

1. Estive sempre distraído e foi impossível concentrar-me no que fosse.	0	1	2	3	4	5	6	Fui capaz de me concentrar rápido e de não me distrair.
2. O meu pensamento foi sempre claro e compreensível.	0	1	2	3	4	5	6	O meu pensamento não foi claro e foi difícil de entender.
3. Os pensamentos e imagens que tive estiveram sob o meu controlo. Eu decidia o que pensava e imaginava.	0	1	2	3	4	5	6	As imagens e pensamentos assaltavam a minha mente sem controlo.
4. Tive uma experiência que podia considerar de muito religiosa, espiritual ou transcendental.	0	1	2	3	4	5	6	Não tive nenhuma experiência que pudesse considerar como religiosa, espiritual ou transcendental.
5. Tive consciência de algumas sensações sexuais muito intensas.	0	1	2	3	4	5	6	Não tive nenhuma experiência de sensações sexuais.
6. Estive silenciosamente a falar comigo de maneira muito ativa.	0	1	2	3	4	5	6	Não me envolvi em nenhuma fala silenciosa comigo próprio.
7. Senti-me muito, muito triste.	0	1	2	3	4	5	6	Não tive nenhum sentimento de tristeza.
8. A minha atenção foi completamente dirigida para a minha própria experiência interna subjetiva.	0	1	2	3	4	5	6	A minha atenção foi completamente dirigida ao mundo à minha volta.
9. Senti-me extasiado e divertido.	0	1	2	3	4	5	6	Não tive sentimentos sobre estar extasiado nem divertido

10. Não me consigo lembrar do que experienciei.	0	1	2	3	4	5	6	Consigo lembrar-me de quase tudo o que experienciei.
11. Em nenhum momento senti que o meu corpo se expandia.	0	1	2	3	4	5	6	Senti que o meu corpo se expandia para lá dos limites da minha pele.
12. Experienciei muitas imagens visuais.	0	1	2	3	4	5	6	Não experienciei nenhuma imagem visual.
13. Não tive consciência de estar consciente de mim próprio. Não tive auto-consciência.	0	1	2	3	4	5	6	Estive muito consciente de estar consciente. A minha auto-consciência foi intensa.
14. Não senti nenhuma emoção de raiva.	0	1	2	3	4	5	6	Senti-me furioso/a.
15. A minha perceção do passar do tempo mudou drasticamente.	0	1	2	3	4	5	6	Não notei nenhuma mudança na minha perceção do tempo.
16. Senti-me muito assustado/a.	0	1	2	3	4	5	6	Não tive nenhuma emoção de sentir-me assustado/a.
17. A minha perceção do mundo mudou drasticamente.	0	1	2	3	4	5	6	Não notei nenhuma mudança na minha perceção do mundo.
18. A minha imagem visual foi tão vívida e tridimensional que parecia real.	0	1	2	3	4	5	6	A minha imagem visual foi vaga e difusa, foi difícil obter alguma imagem.

19. Os músculos do meu corpo sentiram-se muito tensos e apertados.	0	1	2	3	4	5	6	Os músculos do meu corpo estiveram muito soltos e relaxados.
20. Não experimentei nenhum sentimento de amor.	0	1	2	3	4	5	6	Tive sentimentos intensos de amor.
21. O meu estado de consciência não esteve fora nem diferente do que é habitual.	0	1	2	3	4	5	6	Senti um estado de consciência extremamente diferente e inusual.
22. Não me consigo lembrar de nada do que me aconteceu.	0	1	2	3	4	5	6	Consigo lembrar-me de tudo o que aconteceu comigo
23. Tive uma experiência de acolhimento e reverência para com o mundo.	0	1	2	3	4	5	6	Não tive uma experiência de acolhimento e reverência para com o mundo.
24. Conceptualmente, o meu pensamento foi claro e nítido.	0	1	2	3	4	5	6	Conceptualmente, o meu pensamento foi confuso e baralhado.
25. Tive controlo total naquilo a que estava a prestar atenção.	0	1	2	3	4	5	6	Não tive controlo sobre aquilo a que estava a prestar atenção.
26. As minhas sensações corporais pareciam expandir-se ao mundo que me rodeava.	0	1	2	3	4	5	6	As minhas sensações corporais estavam restringidas à área da minha pele.
27. Tive continuamente consciência e fui consciente de mim próprio/a.	0	1	2	3	4	5	6	Perdi a consciência de mim próprio/a.

28. A minha atenção foi totalmente dirigida ao ambiente à minha volta.	0	1	2	3	4	5	6	A minha atenção foi totalmente dirigida ao meu interior, à minha experiência subjetiva.
29. O mundo à minha volta tornou-se extremamente diferente em cor ou forma.	0	1	2	3	4	5	6	Não notei mudanças na cor ou forma do que me rodeava.
30. O tempo parecia passar a grande velocidade ou muito lentamente.	0	1	2	3	4	5	6	O tempo não me pareceu ter sofrido nenhuma alteração, transcorrendo a um ritmo normal.
31. Não tive sentimentos de tristeza ou abatimento.	0	1	2	3	4	5	6	Senti-me triste e abatido/a.
32. Não experienciei um profundo entendimento maior ou diferente do que é habitual.	0	1	2	3	4	5	6	Experienciei um entendimento muito profundo e iluminado de certas ideias e questões.
33. Senti-me muito chateado/a e alterado/a.	0	1	2	3	4	5	6	Não tive sentimentos de estar chateado/a ou alterado/a.
34. Não me distraí, mas fui capaz de estar completamente absorto/a no que estava a experimentar.	0	1	2	3	4	5	6	Estive continuamente distraído/a por impressões ou acontecimentos externos.
35. Não tive consciência de nenhuma sensação sexual.	0	1	2	3	4	5	6	Tive fortes sensações sexuais.
36. O meu modo de processar os pensamentos foi irracional e muito difícil de compreender.	0	1	2	3	4	5	6	O meu modo de processar os pensamentos foi racional e fácil de compreender.

37. Não tive sensações de tensão ou rigidez.	0	1	2	3	4	5	6	Senti-me tenso/a e rígido/a.
38. A minha memória dos acontecimentos que experienciei é extremamente clara e vívida.	0	1	2	3	4	5	6	A minha memória dos acontecimentos que experienciei é extremamente imprecisa e vaga.
39. Não notei que os objetos à minha volta tivessem mudado de tamanho, forma ou de perspetiva.	0	1	2	3	4	5	6	Notei que os objetos à minha volta mudaram de tamanho, forma ou de perspetiva.
40. O meu estado de consciência foi muito diferente do que experiencio normalmente.	0	1	2	3	4	5	6	O meu estado de consciência não foi diferente do habitual.
41. Eu renunciei ao controlo e fiz-me recetivo/a e passivo/a ao que estava a experienciar.	0	1	2	3	4	5	6	Estive a controlar intencionalmente o que estava a experimentar.
42. Não tive sentimentos de estar assustado ou com medo.	0	1	2	3	4	5	6	Senti-me muito assustado/a e com muito medo.
43. Não tive sensação de eternidade, o tempo transcorria como normalmente o experiencio.	0	1	2	3	4	5	6	O tempo parou, não houve movimento do tempo.
44. Não experienciei imagens ou experienciei muito poucas.	0	1	2	3	4	5	6	A minha experiência foi quase só de imagens.
45. Não me envolvi em qualquer fala silenciosa comigo próprio.	0	1	2	3	4	5	6	Estive silenciosamente a falar comigo grande parte do tempo.

46. Não experienciei êxtase ou felicidade extrema mais do que é habitual.	0	1	2	3	4	5	6	Senti-me extasiado/a e extremamente feliz.
47. Não experienciei nenhuma sensação de sagrado ou de uma profunda crença existencial mais do que os meus sentimentos habituais.	0	1	2	3	4	5	6	A existência tornou-se profunda, sagrada ou significativa.
48. As minhas imagens visuais foram muito vagas e difusas.	0	1	2	3	4	5	6	As minhas imagens visuais foram tão claras e vívidas como os objetos do mundo real.
49. Experienciei intensos sentimentos de tipo amoroso.	0	1	2	3	4	5	6	Não tive sentimentos de tipo amoroso.
50. Mantive uma sensação muito forte de consciência de mim todo o tempo.	0	1	2	3	4	5	6	Não mantive nenhuma sensação muito forte de consciência de mi mesmo.
51. Mantive continuamente uma forte sensação de separação entre mim próprio e o ambiente que me envolvia.	0	1	2	3	4	5	6	Em todo o momento experienciei unidade com o mundo, os limites entre mim e o ambiente que me envolvia desapareceram.
52. A minha atenção esteve continuamente dirigida para dentro de mim.	0	1	2	3	4	5	6	A minha atenção esteve continuamente dirigida para o exterior.
53. O meu estado de consciência não foi fora do comum ou diferente do que é habitualmente.	0	1	2	3	4	5	6	Senti um estado de consciência extraordinariamente diferente e fora do comum.

Annex C

Musical Demographic Questionnaire (in Portuguese)

Sexo:	☐ Feminino	☐ Masculino
Idade:		
Nº de anos de prática improvisatória:		
Nº de anos de treino musical:		
Nº de performances de jazz ao vivo:		
Nº de performances musicais ao vivo:		
Instrumento principal:		
Nº médio diário de horas de prática musical:		
Outras observações acerca da sua formação musical que considere relevante:		