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Creative assessment approaches to human interactions and music interfaces technology. A Systematic Literature Review.

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Abstract. This article reviews the state of the art about previous studies which have evaluated interactions between humans and audio music technologies thus far. The objective is to study how many studies have evaluated singular proactive, creative and expressive interaction of technology users. Also included are studies that integrate aspects related to education, health and well-being, to promote a future enrichment of collaborative work among specialized professionals within the designs of creative music technology, and educational teams in which these types of technological interactions are used. The fourth industrial revolution is progressively hypernormalizing creativity, maintaining a false and excesive social normalization of its functional logic. Its techno-symbolic paradigm affects science, education and the use and appropriation of technology. As a consequence, standardization rigidity and automation normalize creative learning processes, generating cognitive dissonance which affect people's health and well-being. This reveals the need to find technology designed to be flexible in humans. This study points to the value of practicing music as one of the most revolutionary creative areas in the field of technological cognitive interactions. Through a mixed methodology, based on collecting, analyzing and interpreting most of the relevant sources in the field, and summarized in three main scientific databases, a small percentage of researchers demonstrate a link to the main objective of this previously described study.

The conclusions show that the scientific community has not focused on the search for inclusive paradigms that integrate a dimension of evaluation which respects the creative capacities of the technological user, based on an open and holistic concept of education, health and well-being. This indicates the opportunity to implement evaluations through music therapists and artistic-creative therapists within the design processes of creative and expressive technology. This would facilitate a critical and proactive search for new, more respectful, flexible technological paradigms. It would also be resilient for education, health and well-being, including frameworks capable of providing viable alternatives to the problem posed by current technological hypernormalization.

Keywords: Hypernormalization; creative learning; music technology; evaluative flexibility; health and well-being

Summary. 1. Introduction. 2. Methodology. 3. Results. 4. Conclusions and discussion. 5. Bibliographic references.

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1. Introduction

Understanding human cognition remains a challenge for science today. Memory, learning, attention, emotions and their communicative expressiveness are some cognitive dimensions involved in understanding decision-making or problem solving. There are magnitudes that try to explain what most defines human development, its potential to be creative and the impact this has on education, health and well-being beyond the idea of technological innovation (Abraham, 2018; Ardila, 2011; Bergson & Andison, 2010; Boden, 2004; Cooper, 2013; Corradini, 2011; Filippetti

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et al., 2015; Velásquez et al., 2006). The difficulty lies in the complexity equired for the study of creativity requires, which is incompatible with the demands of a scientific concept and tends to be unequivocally based on determination and prediction (Vecina, 2006). Perhaps that is why cognitive technology today revisits the unresolved dilemmas of the past (Freud, 1958; Guilford, 1967).

It seems logical to think that the interactions between people and cognitive technology, in its relationship with creativity, education, health and well-being, involve this same complexity, requiring at least a similar understanding (Bayón & Martínez, 2010), delving into the paradigms on which the enormous diversity of cognitive digital interactions has so far been designed (Bellotti et al., 2002; Braidotti, 2015; Cañas, 2003; Fernández & Rahona, 2011; Fumero, 2015; García et al., 2014; Gray & Salzman, 1998; Scolari, 2004).

The relevance of digital media in different creative practices is indisputable. Ribeiro (2018) affirms that the fourth industrial revolution has developed thanks to a financial capitalism with a "techno-symbolic" base. This digital and electronic transformation has used the Internet to grow economically through software and hardware industries. Ribeiro also indicates that various authors refer to an "information economy" (Castells, 1996), a "digital capitalism" (Shiller, 2000), or even a "cognitive capitalism" (Blondeau & Sánchez, 2004; Míguez, 2013; Zukerfeld, 2008). For Ribeiro, these terminologies reveal a controversy on this latter concept, as a descriptor of a change in behavior of the current economic system centered on "the profound mutation that affects the way in which capital is endowed with value" (Corsani, 2003, p. 15). It furthermore emphasizes the concept of immaterial work, since it mobilizes information, knowledge, images, creativity, affections and relationships (Albagli & Maciel, 2010). The notion of immaterial work (Shiller, 2016; cited by Ribeiro, 2018) should be highlighted. It is based on a cognitive process requiring creativity, whose purpose is to generate an informational and immaterial product that affects all types of aesthetic or artistic expression. Moreover, it integrates the work of designers and engineers, whose creativity contributes to an important part of technological innovation.

In spite of its limitations as a research tool, evaluation helps to better understand the functioning of machines and the complexity of human cognition. The problem arises when traditional evaluation models are applied within the field of interaction with cognitive technology, adhering to evaluation frameworks designed for the optimization of machines and industrial standardization (García, 1999) within the evaluation of educational interactions and creative (Bauman, 2007; Robinson, 2015; Selwyn, 2016), contextualized from a posthumanism that bets on artificial automatisms, reducing technological innovation to a simple sketch of intelligence or creative learning (Braidotti, 2015; Guattari, 2007; Sloterdijk, 2005).

Within a techno-symbolic society, consumption and leisure determine the individual and collective creative flow (Bauman, 2012; Baumeister et al., 2007). The globalizing policies of this new cognitive revolution have put the normalized profile of the consumer first, denying the singular identity of the technology user (Fumagalli, 2010; Rasmus, 2019), stripping artists and creators of their immaterial property and creative initiative (Wikstrom, 2005).

This framework has generated the need to explore alternative and flexible ways of understanding the present and future reality of technology. Part of this necessary search is provided by Krippendorf (2016), who assigns an empirical domain to technological design that consists in knowing the possible forms suggested by the objects produced, and how users construct meanings in an individualized way. For this author, the role of the designer is to emphasize the interfaces beyond merely understanding them as objects. This leads to a search for meanings beyong appearances, by showing what the discourse brings to light instead of what has already been normalized. Moreover, it offers a diversity of ideas that can enable different solutions to individual problems. According to this author, the difficulty arises when engineers, artists, communicators and market researchers maintain their interests in other aspects of technological production besides those provided by design. They are professionals who coexist and interact within the technological universe, influencing the organizational dynamics of technical systems, interferening in the final interpretation of objects, which is not always beneficial for innovation. Although Krippendorf appeals to creativity in defense of a design discourse, the designer functions have overtaken the work of the artist, the educator or the therapist, despite its lack of professional deontology to ensure health and welfare.

Llórens (2015) points out that in the 20th century, many thinkers have seen psychotherapeutic thought as a trade dedicated to the construction of interpretive versions of reality. This historical turn allows the different theories to be conceived as a series of metaphorical tools capable of giving meaning to different types of experiences. Thus, the possibility of having interpretative versions of reality in favor of health and well-being is legitimized. According to Llórens, the role of the analyst and also that of the evaluator, is less being conceived metaphorically as that of an archaeologist, and more closely identified as a translator who facilitates the co-adapted dialogue between user and therapist. This ontoepistemological turn coincides with the perception of Krippendorf (2016) when he affirms that reality is not composed of dead objects, but of objects that act in concert with something and with someone. After discussing whether teachers should be included in the technological design process (Kirschner, 2015), designers, artists and artistic-creative therapists are presented as an alternative to technological hypernormalization. Their creative learning and production processes dismantle the automatism of perception, creatively breaking through the limits of standardization and normalization (Scolari, 2004).

The question then arises about whether music therapists and art therapists can actually mediate between the creative and expressive needs of technology users and its designers. This is done by conveying a diversity of ideas that enable different solutions to individual problems, offering different interpretive versions of reality to facilitate

a co-adapted creative dialogue, and favoring the construction of alternative technological interactions that are more considerate of education, health and well-being aspects.

Today there is a large amount of scientific literature that records the intense cognitive and perceptual demands that music involves (Abraham, 2018; Justus & Bharucha, 2002). Thus, the field of music education has undergone far-reaching transformations that delve into the profound implications that musical activities can have. For decades, a more complex and enriching cognitive understanding of music and sound has been investigated (Fenichel, 2002) thanks to the field of recreational, educational, psycho-social or clinical music therapy, among other areas (Aldridge, 1996; Álvarez Suárez, 2019; Augé & Mercadal-Brotons, 2010; Bright, 1993; Darrow, 1993; Daykin et al., 2007; Standley, 2005; Sun et al., 2019; Tamplin & Baker, 2006; Wheeler, 2005). Moreover, it is increasingly evident that music has great potential to integrate a wide range of cognitive, motor and emotional capacities (Brown, 2004; Greenberg & Paivio, 2000; Juliette, 1991; Stewart & Morales, 1990; Vuilleumier & Trost, 2015). It is precisely this integration of diverse capacities that awakens a special interest in the development of interaction between humans and cognitive interfaces, something that is helping to revolutionize areas related to learning, intelligence, memory, perception or psychomotor skills.

Furthermore, researchers are increasingly more aware of the need to find, define or develop new ways of evaluating technological musical interactions and interfaces (O'Modhrain, 2011; Vasilakos, 2016; Yang & Lerch, 2020), some of them including the experience user protagonist (Brown et al., 2017). There is also research integrating the joint aspects of education, health and well-being of users within the design processes of new musical technologies (Casal, 2000; Cerebello et al., 2019; Francis, 2018; Holland & Fiebrink, 2019; Knight, 2013; Krout et al., 1993; Mcgowan et al., 2021; Streeter et al., 2012; Van Besouw et al., 2016).

In any case, the heterogeneity and lack of sources to develop a more creative, open and resilient evaluation, along with the permanent innovation in their aims of study, encumber a minimally comprehensive perspective of the overall dynamics and panorama. Some have proposed an alternative evaluation research type has been proposed (Barbosa et al., 2015; Jensenius, 2014). Therefore, it seems pertinent to focus on this type of publications, in order to better understand the state of research on the exploration of creative evaluation approaches for interactions between humans and music technology interfaces.

2. Methodology

The main aim of this study is to understand the state of the art in research on the exploration of creative evaluation approaches for interaction between humans and technological interfaces for audio music. To do this, a systematic literature review literature (SLR) was carried out, as a means of evaluating and interpreting the available research, which is relevant to the questions proposed in the thematic area or of interest in the specific research. (Kitchenham, 2004).

To carry out this review, a research protocol was designed following the suggestions of García-Peñalvo (2017), in order to answer the following research questions:

- RQ 1. What is the current state of research related to evaluations of music technology interfaces and interactions?
- RQ 2. How many investigations do you evaluate by means of the interactive, singular, proactive, creative and expressive experience of each technology user?
- RQ 3. How many investigations do you evaluate integrating the joint aspects of education, health and well-being of users within the design processes of audio music technologies?

Taking into account the research questions, a series of terms connected by means of Boolean operators were used and the following search string was used: "Music interface evaluation" or "Musical interface evaluation".

The search for research works was carried out in the scientific databases of GOOGLE SCHOLAR, SCOPUS and ISI-WOS, with the intention of covering the largest number of works published in the most recognized journals, including conference proceedings and theses or degree projects in relation to the central theme of this research. Prior to the selection of works, a preliminary search was carried out to validate, on the one hand, the aforementioned repositories, and on the other, the search chain, in order to identify relevant articles and research. The results of the chain application in the three repositories have been recorded using Google spreadsheet software, reflecting a total of 263 results, to which the following inclusion / exclusion criteria were applied to ensure that they were only reflected in that research:

- Out of focus: Publications that did not contain at least the words „evaluation" in relation to any type of audio music technology in their title, except for certain publications that in their abstract did develop creative evaluation approaches for interactions between humans and technological interfaces for music.
- Language: Studies published in a language other than Spanish or English.
- Duplicate articles: Publications that are found repeatedly in the output of the different repositories.

– Incorrect or incomplete format: the study has focused preferably on articles and conference proceedings, avoiding unstructured, incomplete or edited sources in formats not conforming to standardized scientific norms.

It is important to clarify that of the sources found, studies that do not include the word "evaluation" in the title of their publication have been excluded. However, certain publications have been included that, because the abstracts indicated that approaches used could be verified and furthermore answered some of the research questions proposed. A priori, the exclusion of those documents that had not passed the peer review filter was proposed, but due to the lack of specific sources, it was decided to open the focus to those sources that develop a creative, open and resilient evaluative perspective.

The initial detailed examination showed a great heterogeneity of common acronyms in the sources found. This reflects the presence of various communities dedicated to the study and development of new technological concepts, including conferences that eventually have also been configured as communities in which aspects related to technological innovations are usually debated. Some of the most important communities are New Interfaces for Musical Expression (NIME), The International Computer Music Association (ICMA), The International Computer Music Conference (ICMC), Association for Computing Machinery (ACM), Audio Engineering Society (AES), Human Factors in Computing Systems (CHI), Conference on Information Technology and Electrical Engineering (ICITEE), Joint conference on digital libraries (JCDL), IEEE International Conference on Multimedia Information Processing and Retrieval (IEEE-MIPR), Recommender Systems conference (RecSys) and The Web Intelligence Consortium (WIC).

This variety of acronyms shows a plurality in the main research, development and innovation objectives. They are objectives that usually support deeply differentiated conceptions, both of interactions and technological interfaces. Many of them are general technological concepts that are applied ever more frequently in the field of audio music technologies. Among this diversity of concepts related to technological interaction is found Multimedia Information Processing and Retrieval (MIPR), Music Information Retrieval (MIR), Music Digital Library (MDL), STEAM (Science, Technology, Engineering, Arts and Maths), Human-Computer Interaction (HCI), Web Intelligence (WI), Intelligent Agent Technologies (IAT) and Digital music interfaces (DMI).

This heterogeneity, reflected in the different technological conceptions, shows that the chain of words chosen for the search of sources was open enough to find a wide variety of investigations capable of mapping the state of the art in question. Once the exclusion criteria were applied to the 263 selected sources, 76 documents were accepted and 187 were discarded, applying the different exclusion criteria previously determined (Table 1). Of the total accepted sources, 84.5% belong to scientific articles, 10.5% to doctoral theses, 2.5% to master's works, and finally 2.5% to other formats.

Table 1. Source selection process.

Source	Inicial number of results	Accepted	Exclusions			
			Out of focus	Duplicates	Language	Format type
Google Scholar	207	69	132	1	2	3
Scopus	18	3	15	0	0	0
ISI WOS	38	4	12	22	0	0
Total	263	76	159	23	2	3

It is clear that the higher percentage of excluded sources is due to the fact that these have been found outside the focus of the investigation, that is 85% of the total, as reflected in Figure 1.

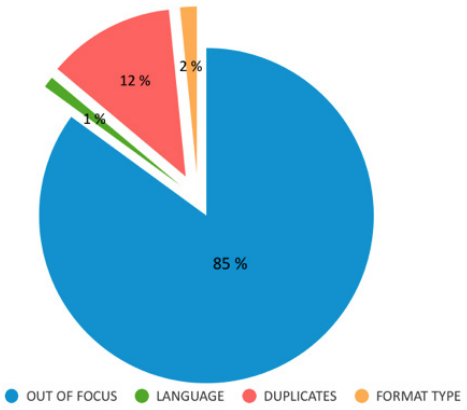


Figure 1. Percentage of excluded sources, see Table 1.

The entire process followed to carry out the SLR can be consulted in the shared excel document online[4].

Once the 76 pertinent investigations were accepted from the total of sources, and the most relevant information were extracted from each of them, then a descriptive analysis of the data was carried out, in order to answer the research questions in a more detailed way. In the first place, it should be noted that, of all the 76 sources related to the research questions RQ 2 or RQ 3, 54 of them develop RQ 2, and 9 develop RQ 3, while 13 show a joint correlation and significance with questions RQ 2 and RQ 3 (Table 2).

Table 2. Number of sources dealing with RQ 2, RQ 3 or both.

Selected sources	RQ2	RQ3	RQ2 & RQ3
Google Scholar	48	9	12
Scopus	3	0	0
ISI WOS	3	0	1
Total	54	9	13

The largest number of relevant documents was found on Google Scholar, followed at a distance by ISI WOS. 71% of the documents develop topics related to forms of evaluation that integrate the unique proactive, creative and expressive interaction of technology users. However, on this type of evaluation developed from the proactive, creative and expressive technological interaction, only 17% of the pertinent sources show evaluative experiences, which also integrated potential interrelated aspects with the education, health and well-being of users (Figure 2).

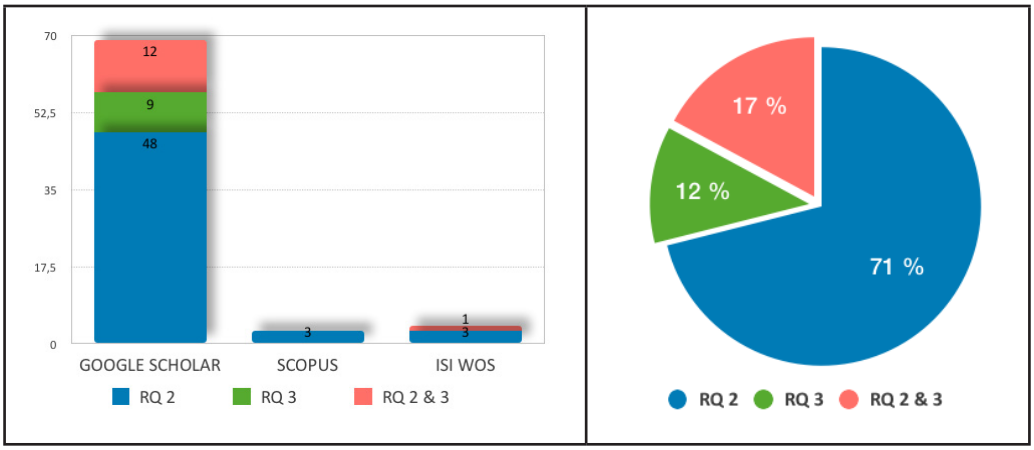


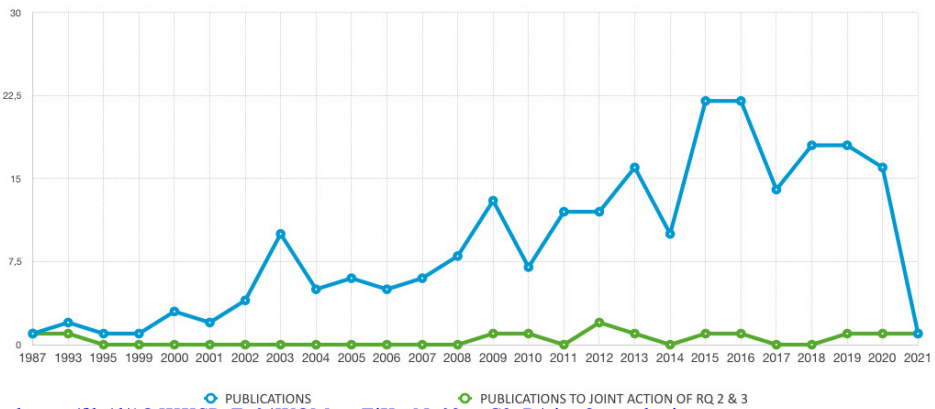
Figure 2. Number and percentage of sources that deal with RQ 2, RQ 3 or RQ 2 and RQ 3, see Table 2.

3. Results

The results related to the three questions that make up this research are presented below:

RQ 1. What is the current state of research related to evaluations of music technology interfaces and interactions?

To answer RQ 1, an unlimited and open search in the servers already described has been prioritized, given the scarcity of research related to this type of very specific evaluations. Thereafter, the results are reflected by years of publication, generating a comparison between the total sources obtained and those that are developed in relation to the joint research questions RQ 2 and RQ 3.



[4] https://drive.google.com/file/d/1O5KKSP_Fy04WQMu_uEjKyrNp02amC3gR/view?usp=sharing

Figure 3. Year of source publications

Figure 3 shows a huge difference between the number of publications that develop RQ 2 or RQ 3 and the number of investigations related to the joint action of RQ 2 and RQ 3. It is important to reiterate that 71% of the sources selected respond only to RQ 2. Another important issue is that research related to evaluations of musical interfaces began to increase from the year 2000. However, those that develop an evaluation of proactive, creative and expressive musical technological interaction, integrating potential joint aspects of education, health and well-being, maintain a practically flat behavior for more than three decades.

There are three important increases, after 2003, in 2009 and 2013, and between 2015 and 2016. The total increase that occurs in 2003 is not accompanied by the increase in publications in reference to the joint action of RQ 2 and RQ 3, although the successive total increases in 2009, 2013 and between 2015 and 2016 are accompanied by a slight increase in publications in reference to the joint action of RQ 2 and the RQ 3.

It is interesting to note that these latest increases ocurred during the economic crisis period from 2008 to 2018. It is also possible to observe a deeply accentuated decrease in the total number of publications since the beginning of the global Covid-19 pandemic, a decrease that is not accompanied by the publications referring to the joint questions RQ 2 and RQ 3 in this crisis period, since they maintain a practically flat behavior to date.

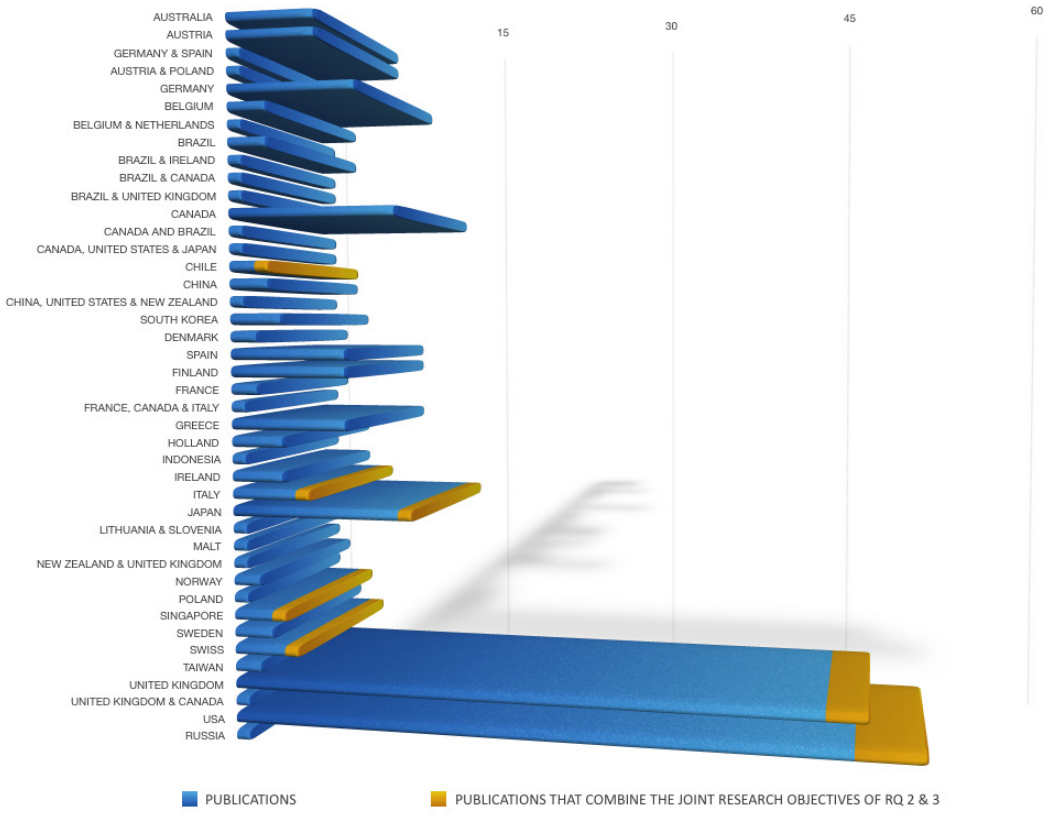


Figure 4. Distribution of sources by country.

Regarding the distribution of publications by country (Figure 4), there is a predominance of countries with an evident technological superiority, boosted by an Anglo-Saxon music market that enriches investment in the research, development and innovation of specialized technology. Other significant countries in terms of the number of publications are Japan and Germany, and to a lesser extent Finland, Spain, Austria or Greece, all being secondary or tertiary powers that also tend to collaborate within this type of technological research.

Figure 4 and Table 3 show that the investigations come predominantly from two countries, the United Kingdom and the United States, with a strong presence of some of the main members of the former or current Commonwealth, such as Canada, Australia or New Zealand. There were frequent collaborations among cultural partners or emerging technological powers, such as the USA and Canada, the UK and Brazil or the UK and New Zealand. The same can be said with respect to publications related to the joint development of RQ 2 and RQ 3, since in this case the fundamental representation is also carried out by the United States and the United Kingdom, but also to a lesser degree by Japan, Singapore, Chile, Italy or Switzerland.

RQ 2. How many investigations do you evaluate by means of the interactive, singular, proactive, creative and expressive experience of each technology user?

As Table 4 shows, of the total selected sources, the investigations by topic that can answer this question are those that evaluate the design of interfaces and technological-artistic-creative interactions; those that integrate aspects related to health and well-being; those that address educational aspects; and finally those that propose interactive experiences through creative

production and learning, integrating aspects of education, health and well-being within the development of technological designs. This indicates that 55.2% of the research could respond to RQ 2. The countries with the most publications within this percentage are basically the USA, UK and Canada. However, Spain and Singapore discreetly star with a significant contribution within the 11.8% of sources that address educational aspects within the evaluations.

Table 3. Countries that collaborate on your publications

COUNTRIES	NO. OF PUBLICATIONS	PUBLICATIONS IN REFERENCE TO RQ 2 & 3
AUSTRIA, GERMANY AND SPAIN	1	0
AUSTRIA AND POLAND	1	0
BELGIUM AND NETHERLANDS	1	0
BRAZIL AND IRELAND	1	0
BRAZIL AND CANADA	1	0
BRAZIL AND UK	1	0
CANADA AND BRAZIL	1	0
CANADA, USA AND JAPAN	1	0
CHINA, USA AND NEW ZEALAND	1	0
FRANCE, CANADA AND ITALY	1	0
LITHUANIA AND SLOVENIA	1	0
NEW ZEALAND AND UK	1	0
UK AND CANADA	1	0

Table 4. Amount of research, percentage and countries with more publications by topic

INTEGRATED TOPICS WITHIN TECHNOLOGIES	NO. OF INVESTIGATIONS BY SUBJECT	PERCENTAGE BY SUBJECT	COUNTRIES WITH MOST PUBLICATIONS BY SUBJECT
MIR (PLAYLIST & STREAMING)	6	7,9 %	USA
AUTOMATION	3	3,9 %	UK
DESIGN MUSICAL INTERFACES	25	32,9 %	CANADA & UK
DESIGN OF ARTISTIC-CREATIVE INTERFACES AND INTERACTIONS	20	26,3 %	UK
ASPECTS RELATED TO HEALTH AND WELL-BEING	10	13,2 %	UK & USA
ASPECTS RELATED TO EDUCATION	9	11,8 %	SPAIN & SINGAPORE
INTERACTIVE, CREATIVE AND EXPRESSIVE EXPERIENCES THAT INTEGRATE INTO TECHNOLOGICAL DESIGNS MUSICAL CREATIVE LEARNING, HEALTH AND WELLNESS	3	3,9 %	USA, AUSTRALIA & CHILE
TOTAL SOURCES SELECTED	76	100,0 %	

RQ 3. How many investigations do you evaluate integrating the joint aspects of education, health and well-being of users within the design processes of audio music technologies?

As shown in Table 4, of the total selected sources, only those that propose interactive experiences through creative production and learning, integrating aspects of education, health and well-being within the development of technological designs can answer this question, that is 3.9% of the selected sources can answer RQ 3. Likewise, the countries with the most publications within this small percentage are mainly the USA and UK, with one very up-to-date contribution from Chile.

Despite the fact that only 76 documents have answered the questions proposed in this research, specific information referring to the most prolific authors in their publications has finally been incorporated from the total number of documents obtained in the initial search.

In order to provide qualitative information as complete as possible, the profile of these researchers is also provided, showing their possible scientific bias within the purpose of the research, since it can also provide a better understanding of the scientific literature dedicated to evaluating the interactions between humans and musical technological interfaces.

Only 76 documents have answered the questions proposed in this research. Thus, in order to provide information which is qualitatitvely as complete as possible, the specific information referring to the most prolific authors is incorporated into their publications from the total documents obtained in the initial search. Understanding the profile of researchers and their possible scientific bias within the aim of their investigations also

provides a better grasp of the scientific literature which evaluates interactions between humans and audio music technology interfaces.

Table 5. Most prolific authors in their publications

AUTHORS	MAIN RESEARCH TOPICS	NO. OF PUBLICATIONS
JERÔNIMO BARBOSA	FORMS OF EVALUATION OF MUSICAL INTERFACES	3
BRECHT DE MAN	MAINLY TECHNICAL ASPECTS OF INTERFACES	3
J. STEPHEN DOWNIE	MUSIC INFORMATION RETRIEVAL (MIR)	9
JON FRANCOMBE	EVALUATION, OPTIMIZATION OF INTERFACES AND BROADCAST	3
XIAO HU	MUSIC INFORMATION RETRIEVAL (MIR) AND USER EXPERIENCE	3
YUCHEN JIN	DESIGN OF USER INTERFACES AND INTERACTIONS	3
ARTO LEHTINIEMI	PLAYLISTS AND SOCIAL INTERACTION	7
MUNEYUKI UNEHARA	GENETIC ALGORITHMS AND MUSIC COMPOSITION	3
ROBERT E. KROUT	MUSIC THERAPY AND TECHNOLOGY	2
ELAINE RUTH STREETER	DATA EVALUATION AND ANALYSIS; MUSIC THERAPY AND DATA ANALYSIS: MUSIC THERAPY IN NEURODISABILITY	2

The most frequent topics of interest are usually related to the different forms of music information retrieval (MIR), there being a special interest in playlists and streaming music, when considering the interaction used on social networks dedicated to online music playback. Here the user experience is integrated in a limited way. The automation of network services often complements the main technological interest within the audio music field.

Another focus of evaluative interest deals with the design of requirements for audio interfaces for music, understood as tools or means to make music. Artificial intelligence, through algorithms and neural networks applied to composition, finally completes the interest in the production and post-production of music, understood as a functional audiovisual product. This perspective includes certain aspects related to human expression, gestures or emotions. To a lesser degree, there are publications that evaluate the designs of interfaces and user interactions in purely artistic environments, either in live music production or in music improvisation. Only two publications integrate aspects of health and well-being, most of them developed for or based on security requirements and designed for the use of hardware or dedicated to technological aspects that impact the health and physiological well-being of people. Four publications are concerned with integrating the interactive, proactive and unique experience into the evaluations of audio music technology design, facilitating each user's development of their own creative and expressive capacities in each musical interaction. These also evaluated cognitive aspects involved in a holistic idea of education, health and well-being.

This research included music therapy and technology studies, in which either disabled people or professional therapists are also identified as users. Thus, their participation in the technological designs of the different interfaces are integrated in a limited way and almost always only in the early stages and outside of the design process.

Regarding the specific profile of the most prominent researchers by number of publications, Table 5 shows that J. Stephen Downie, with nine publications and Arto Lehtiniemi, with seven, are the authors with the most publications of the total 263 documents obtained. J. Stephen Downie investigates the design and evaluation of information retrieval systems, including the retrieval of multimedia music information. However, he has also investigated the political economy of interconnected communication systems and the design of databases or technologies based on the web (University of Illinois Urbana-Champaign, 2021). Arto Lehtiniemi, is a specialist in computer science, immersive audio technologies and user experience, who addresses the user experience and its implications in technological design in his research. (Linkedin, 2021).

Table 5 highlights that Dr. Robert E. Krout and Dr. Elaine Ruth Streeter each have two publication and the highest number of publications in relation to the joint development of RQ 2 and RQ 3.

Dr. Robert E. Krout is a music therapist specializing in Special Education. His work focuses on the development of applications for evaluations of music therapists, and to facilitate the work by special education students (Lessonface, 2014).

Finally, as a researcher in the Department of Electronic Engineering at the University of York, UK, the works of Dr. Elaine Ruth Streeter address computer-assisted assessment for music therapists in neurodisability settings, music for children and young people with complex needs, and data analysis to evaluate the evidence for the effectiveness of music therapy treatment in neuro-rehabilitation patients.

4. Conclusions and discussion

There is evidence of a heterogeneity of approaches that attempt to evaluate through different objectives and approaches. Most of the investigations work from a hedonic approach and integrate a limited user participation in the creative processes determining the design of the technological requirements. Thus, it is verified that the conception of evaluation takes on very different dimensions, depending on the theoretical or professional field of each researcher, a reality which has been described previously (Barbosa et al., 2015; Krippendorf, 2016; Jensenius, 2014).

The nine documents that hedonically evaluate aspects related to the health and well-being of users within the design requirements of interfaces or music technology interactions are limited to possible technological adaptations that contemplate the concept of physiological ergonomics, to the detriment of cognitive ergonomics. In turn, of the thirteen documents responding to the questions on how many investigations evaluate through the interactive, singular, proactive, creative and expressive experience of each technological user (RQ 2) and how many evaluate also integrating joint aspects of education, health and well-being of users within the design processes of audio music technologies (RQ 3). Most are limited to the design of applications adapted to physical or perceptual, auditory or visual disabilities, without integrating cognitive aspects registered in real time user behavior. In some cases, the potential of creating a software adapted to the professional needs of music therapists is evaluated.

The United States and the United Kingdom stand out in the total number of publications, being the two countries with the greatest cultural diffusion of their music industry within a globalized context. Its commercialized conception of music production means that most of the evaluations focus on the design, development and innovation of technology aimed at the distribution and consumption of digitalized music online. There is a growth in total number of sources, driven by the digital changes in the new millennium. This increase does not occur with publications related to the conjunction of the research questions described above. The behavior of this last group of publications remains practically flat to date, regardless of the consequences derived from the socioeconomic crises, which are far removed in number from the total number of publications. Furthermore, the notable increase in the number of publications between 2009 and 2016, along with the pronounced decrease in the total number of publications since the beginning of the global pandemic, reflect a possible significant correlation worth being studied in the future.

It is concluded that the context described in the current period of socioeconomic recession and the decline in this type of very specific research could have an explanation related to a possible gender perspective (Andersen et al., 2020; del Moral et al., 2015; Pinho-Gomes et al., 2020). This is perhaps combined with possible factors affecting the endemic crisis of the current music industry, in relation to a transfer of psychic income that are steadily declining in pursuit of increased performance and broadcast rights revenue, indicating the development of a new digital media industry (Lozic, 2020). This is an industrial format bringing significant benefits to streaming music monopolies, economically impoverishing creators and hypernormalizing creative music and productive processes.

On the other hand, the latest increases in publications within the crisis period from 2008 to 2018 (Lansac Colom, 2019; Ramus, 2019), lead to a drastic fall in that reflects the current global crisis. Based on this fact, and in the face of a normalization of the use and appropriation of new cognitive technologies that affect science, education, health and well-being, carrying out exhaustive evaluations is currently an area of interest within the investigation of music technology interaction. This is especially true, if said evaluations explore the subjective experience of each user, in order to better understand a broader and more flexible idea of usability and ergonomics that integrates other important components of user experience, such as charm, motivation or frustration. These cognitive aspects along with others can often be erroneously overlooked in evaluations and research (Brown et al., 2017).

The scientific community needs to focus on the search for inclusive paradigms that integrate a dimension of evaluation that is respectful with the creative capacities of the technology user, based on an open and holistic concept of health and well-being. Music & Medicine magazine, accessible in Scopus, does not have a single indexed article. Therefore, once the suitability of including teachers within technological design processes has been discussed (Kirschner, 2015), designers, artists and creative arts therapists could provide a more viable alternative to the problem posed by current technology hypernormalization.

The magnitude of the present crisis leads to a critical search for new paradigms that redefine technology, education, health and well-being, understanding that future evaluations must include professional art and music therapists within the interaction on design teams to develop cognitive, creative and expressive interfaces. This collaboration must go beyond the development of designs in the early stages, and not only within the frameworks that configure music technologies, but also during the different iterative processes that should optimize the technologies devised to benefit the health and well-being of each and every user.

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