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# Soundscape Composition in the Framework of Cognitive Systems

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**Abstract**

After more than fifty years of development, soundscape composition has evolved from its initial purposes of education and archival work into a significant branch of contemporary music creation. With the advancement of recording technology, digital audio processing tools, and computer music software, the creative means of soundscape composition have been greatly expanded. At the same time, soundscape composition requires composers to make comprehensive use of multiple fields such as technology, art, science, society and culture. However, this also introduces more complex creative challenges, as composers may need to efficiently coordinate the use of various tools in multitasking environments and manage multidimensional interactive scenarios, which demands higher levels of cognitive ability and clearer workflow. This paper aims to discuss my own soundscape composition project within the framework of cognitive theories (extended mind and distributed cognition), in order to explore underdeveloped perspectives on the practice and learning of soundscape composition. This perspective may provide soundscape composers with a richer cognitive theoretical foundation and potential methodological support in the creative process, helping composers or researchers understand the dynamic cognitive processes of soundscape composition based on an analysis of the entire environment.

**Keywords:** soundscape composition, field recording, distributed cognition, extended mind, ethnography, cultural

## 1. Introduction

Since the 1970s, when Canadian composer Murray Schafer introduced the concept of soundscape, the practice and research of soundscape composition have undergone continuous development and advancement. Barry Truax described some characteristics of the recording and editing practices in the field of soundscape composition in the early 1970s, such as the use of a stereo Nagra IV-S and a pair of AKG condenser microphones as recording equipment, and the transparent editing and mixing of unaltered original recordings, which were the main studio techniques at the time (Truax, 2002). Since then, technological advancements have provided composers with more options, whether in the diversity of recording equipment, the flexibility of post-production tools, or even the customization of live sound system designs, all of which have become much broader in scope. Truax stated that soundscape composition has developed rapidly from its origins to the present, and he highlighted the diversity and complexity in its creative approaches and technical applications (Truax, 2002).

*Sichuan Flavor Aesthetics* is a soundscape work composed by the author; it involved multiple stages, including preliminary research, equipment preparation, field recording, sound design and so on. The project was also based on some innovative creative methods. During the creation process, the composer faced the challenge of undertaking multi-tasking and adjusting to multi-dimensional interactive scenarios. Additionally, given the rapidly changing tech-scape, this soundscape composition practice is situated within a context of uncertainty and disorientation.

As the creator, my cognition throughout this process was dynamic, undergoing continuous changes and

adjustments during the creative design phase, which significantly influenced the final work. This research attempts to use this practice as a case study to explore the possibilities and limitations of applying cognitive theory effectively in making such soundscape compositions.

The sources of cognitive theory that we explore in this paper are largely based on the concept of extended mind proposed by Clark and Chalmers in their 1998 book *The Extended Mind*, and by the distributed cognition system proposed by Ed Hutchins in his 1995 book *Cognition in the Wild*. Both theories acknowledge that cognitive processes are not limited to the inside of an individual's brain, but can be extended to the external world, such as tools and environments. Both theories emphasize the importance of tools and environments and focus on the dynamic interactions within cognitive processes. At the same time, they recognize that cognition is influenced by socio-cultural contexts, history, and technological development. Naturally, there are differences between the two theories. For example, extended mind focuses more on how individuals expand their cognition through tools and the environment, whereas distributed cognition emphasizes the cognitive processes involved in collaboration within teams and social systems. In his article *The cultural ecosystem of human cognition*, Hutchins discusses some of the relationships between distributed cognition and extended mind, suggesting that there is considerable overlap between distributed cognition and extended mind practices (Hutchins 2013; Michaelian & Sutton 2013) and are complementary, but there are conceptual, boundary and applicability differences between the two, for example, extended mind is suited to understanding cognitive systems on a specific temporal and spatial basis, whereas distributed cognition does not assume that there is a center of any cognitive system, and takes a wider perspective on to understand cognition and is suitable for examples of practice that cover multiple spatial and temporal scales. (Hutchins, 2013) Due to the challenges of this soundscape composition project, which involved traveling to an unfamiliar destination for field recording, integrating computer programs into the recording process, operating various recording devices, and adjusting the recording plan based on auditory perception, I conducted some research before starting the project.

However, it was found that most discussions on soundscape composition focus on topics such as sound walking, listening, interdisciplinary approaches, and how to use electroacoustic techniques to process sound materials, there is limited analysis and discussion regarding the creator's cognitive thinking and creative behavior. Nevertheless, cognitive science offers a referential conceptual framework that can help us understand the complex cognitive interactions involving individuals (or multiple people) and technological tools. While this framework is not foundational, it can effectively aid in understanding the complexity of these creative activities. Since its inception, the distributed cognition framework has been applied in various domains, including but not limited to: the cockpit system (Hutchins, 1995a), the ship navigation (Hutchins, 1995b), air traffic control (Halverson, 1995), collaboration in network technology and engineering (Rogers, 1992; 1993), the design of meteorological information systems (Kelder & Turner, 2004), medical informatics (Hazlehurst, Gorman, & McMullen, 2008), museum exhibitions (Achiam, May, & Marandino, 2014), educational practice (Karasavvidis, 2002) and joint music composition (Nabavian, 2010) etc. According to Perry, the application of distributed cognition theory in different domains demonstrates its diversity. He emphasizes that it is not merely a theory about individual psychological activities, but rather involves the interaction of individuals with the external environment and external representations, such as tools and cultural symbols, and how these support individual or collaborative actions. (Perry, 2003) This research aims to explore underdeveloped perspectives on soundscape composition practices and learning by discussing my own soundscape composition project within the framework of cognitive theories (extended mind and distributed cognition). This perspective may provide soundscape creators with a richer cognitive theoretical foundation and potential methodological support during the creative process, especially in the context of the ongoing iterative interaction between advancing science and technology and human creativity.

## 2. Soundscape Composition

Schafer notes that soundscape research is an interdisciplinary field established between science, society, and the arts. (Schafer, 1993) In the 1970s, pioneering R. Murray Schafer initiated exploration into soundscapes through the World Soundscape Project (WSP) at Simon Fraser University. Truax argues that although this project was primarily for educational and archival purposes, it still contributed to the development of a unique form of "electroacoustic music", which he termed "soundscape composition" (Truax, 1984, 1996, 2000, 2002). However, the existing literature on soundscape composition mainly focuses on introducing macro compositional methods, case studies (Truax, 2002), establishing platforms to facilitate collaborative field recording, sound exploration, and soundscape creation (Freeman et al., 2011), integrating ethnography with acoustic music (Levack Drever, 2002), and using personal listening as the background for soundscape composition (Findlay-Walsh, 2018), among others. This paper, through the study and research of cognitive theories (especially extended mind and distributed cognition), attempts to begin by examining my own soundscape composition practice. It aims to provide soundscape researchers with a new perspective, one that shifts attention from the individual brain to cognitive processes within social and environmental contexts, thereby exploring new possibilities for the

development of the soundscape discipline. In this Chengdu soundscape composition project, the author's identity as both sound recordist and creator forms a coupling relationship with the tools (recording equipment, computer programs, mobile phone navigation, etc.) and the environment (Chengdu). However, as an extension, especially within the framework of distributed cognition theory, it can be applied to some specific soundscape practice projects involving collaborative efforts among multiple individuals. For instance, it is suitable for scenarios where multiple people coordinate using equipment and systems to establish urban sound archives. Alternatively, soundscape researchers can collaborate with communities by engaging local residents in collecting and recording environmental sounds, thus involving community members in the process of music creation. An example of a more complex compositional scenario: in 1974, during the production of the ten-part radio series Soundscapes of Canada for the CBC, collectively created works such as Summer Solstice were grouped together. The piece comprised short segments recorded over a twenty-four hour period edited together to create a specific soundscape experience for one hour. (Truax, 2002) As some soundscape composition practices in certain specific situations consists of a dynamic and complex process that involves the influence of many internal and external factors related to personnel coordination, tool use, socio-cultural aspects, etc., the cognitive system needs to be adapted and continually optimized by interacting with the environment to ultimately enhancing the creative process.

## 3. Cognitive Ethnography

In Drever's article *Soundscape Composition: The Convergence of Ethnography and Acousmatic Music* (2002), the artist is viewed as an ethnographer. Drever suggests that soundscape compositions convey more information to the listener about the composer's cultural background and listening habits, with these works having little to do with the actual research location. (Drever, 2002) This current paper argues that such a relatively traditional cognitive perspective confines soundscape composition to a very narrow space. Hollan, Hutchins, and Kirsh argue that within the framework of distributed cognition, "cognitive ethnography" needs to shift toward an event-centered approach (where traditional ethnography focused on individual knowledge but neglected action), emphasizing that systems larger than the individual (including the environment, tools, social structures, etc.) influence cognition and focusing on how these systems use knowledge for practical actions or operations (Hollan et al., 2000). Perry believes that Hutchins' cognitive ethnography is beneficial because it allows researchers to describe and explain behavior and information processing within functional systems, making it more suited to the needs of cognitive science (Perry, 2003). Walker et al. argue that ethnography limits the application of distributed cognition in command and control environments and hinders the use of potentially useful and advanced methods for analyzing complex systems. They propose the need to go beyond ethnography (Walker et al., 2010). The proposition of this article is that ethnography, as a research method, is used to document and analyze cultural and social behaviors. Viewing soundscape composers as ethnographers, with a focus on their individual contributions, can lead to overlooking the deeper connection between composition and environment. Distributed cognition theory can be used to expand the scope of traditional ethnography, offering a broader perspective for soundscape composition by emphasizing the impact of environmental and social factors on the compositional process.

## 4. Cognitive Systems in Theory and Practice

Clark and Chalmers advocate for "an active externalism, based on the active role of the environment in driving cognitive processes." (Clark & Chalmers, 1998) Kirsh, and Maglio use the example of Tetris to illustrate that cognitive processes are the result of a combination of internal and external systems and are applicable to all human activities in general. For example, in Tetris, the actions of rotating and moving the blocks to better identify and select candidate positions are accomplished through interaction with the game environment (Kirsh, & Maglio, 1994). Rupert emphasizes that human thought extends into the environment beyond the boundaries of the body (Rupert, 2009). Gibbs, on the other hand, supports a perspective different from that of traditional cognitive science, which focuses on how the external world forms representations within the brain. Instead, he emphasizes the dynamic and interactive processes between behavior and the environment, and the continuous adjustments between the body and the environment (Gibbs, 2005). Admittedly, many negative evaluations of distributed cognition are inevitable. Button's objection to cognitive science is that its description of the cultural world is meaningless; it is simply a redescription of the known world through everyday descriptions. (Button, 2008) Norton counters Button's argument by arguing that distributed cognition is not a case of redundant cognitive descriptions, but rather a valid concept that focuses on specific means of information processing and is useful for a deeper understanding of cognitive phenomena in socio-cultural systems. (Norton, 2020)

Magnus explores the application of the distributed cognition framework in scientific research, suggesting that a standard for distributed cognition includes systems where individuals use tools, multiple people participate collaboratively, and humans and tools engage together. He argues that the description of distributed cognition may reveal important features of our scientific practices, which are not incidental (Magnus, 2007). Cheon points

out the confusion between distributed and extended cognition in Magnus's view, arguing that distributed cognition cannot simply be regarded as an extended process of cognitive tasks in philosophy of science research. He also proposes a modified characterization of distributed cognitive systems, while affirming that scientific practice can be better understood by analyzing distributed cognitive systems. (Cheon, 2014) Since the main purpose of this paper is to investigate how cognitive systems can effectively serve my own soundscape composition practice, there will not be much philosophical discussion. Although the motivations and theoretical details of extended mind and distributed cognition have many differences that are worth discussing, the scope of this paper is limited to some of their common characteristics, such as transcending individual cognition, coupled systems of tools and environments, extensions of the cognitive system, dynamics, and interactivity, and so on.

In his article *Hearing How It Feels to Listen: Perception, Embodiment, and First-Person Field Recording* (2019), Iain Findlay-Walsh introduces practices and cases based on first-person field recording. He defines first-person recording as a method and culturally significant material that guides the creation of sound and acoustic arts. Findlay-Walsh emphasizes the importance and potential of first-person field recording in capturing and presenting personal auditory experiences. In this soundscape project I worked on, different theoretical foundations were applied, emphasizing that the creative process, including field recording, extends beyond the individual creator's mind and is distributed throughout society and the environment. This includes interactions among tools, symbols, culture, and the recorded sources. Certainly, there is no contradiction between these two approaches, and this paper does not exclude the use of first-person field recording to guide soundscape composition. The two approaches can even be complementary, and by combining subjective experience (first-person perspective) and the role of external tools and environments (extended mind and distributed cognition systems), they can be better understood and serve the practice of soundscape composition. Gibbs states that despite the skepticism of traditional cognitive science about the first-person tone of human experience, it is only by incorporating a third-person perspective that a full understanding of the relationship between subjective human experience and objective phenomena can be gained. (Gibbs, 2005) Furniss et al. affirm that the application of distributed cognition theory provides value in the description and explanation of how information flows through socio-technical systems. It also concludes that distributed cognition has a limited role in tuning individuals or emotions, but its strength lies in its structured way of thinking, which helps to understand and solve problems in modern complex systems. (Furniss et al., 2019)

## 5. The Application of Distributed Cognition Theory in Soundscape Composition and Cultural Understanding

As one of the key figures in Distributed Cognition Theory, Hutchins views himself as an ethnographer who demonstrates empirical support and application of the theory by delving into a variety of real-life scenarios, with seafaring as a prime example. In his book *Cognition in the Wild* (1995), he describes how the crew accomplishes the task of navigation by working together with the navigational tools and the ship's systems as a whole, and that this cognitive activity encompasses both the mental activity of the individual, the functional mechanisms of the ship itself, and the interactions with the rest of the crew. Crew members each perform specific tasks, such as measuring position, bearing, and speed, and coordinate through intercoms and logbooks. The cartographer uses this information to plot the charts, while parameters from radar, satellites, and other sources are compared with the recorded data. After observing this information, the navigator issues orders to the helmsman. Keller's assessment is that Hutchins, through his detailed description of the collaborative navigation of naval personnel on U.S. Navy ships in complex cultural and organizational environments, demonstrates the critical role of cultural tools and socialization in situated intelligent activities. (Keller, 1996) Giere argues that Hutchins' concept of distributed cognition goes beyond collective cognition. He includes not only people but also instruments and other artefacts as part of the cognitive system. (Giere, 2007) Turning to my own project, the Chengdu soundscape project, the process here went beyond simply recording the sounds heard by the creator to involve more sophisticated situations. For example, this work was placed within a larger framework of cultural hybridity. In approaching this piece, I needed to consider collecting sounds with cultural significance, which included finding unique local sound sources and visiting and locals such as Sichuan opera artists as part of the plan. Additionally, in the current context of continuous iteration and development of software and hardware, the creator needed to leverage various external resources. For instance, the Chengdu soundscape composition project used various types of microphones as sampling devices. These microphones differed greatly in their usage methods and had entirely different characteristics, requiring the recording engineer to have a good grasp of professional knowledge. In recording the sounds for the project, the recording approach had to be adjusted for the changing situation, deciding which microphone to use to record which type of sound, and understanding what kind of effect would ultimately be produced. These were all dynamic processes. The theory of distributed cognition was used to analyze and help understand the challenges I encountered in this project, and it may also serve as a useful tool for similar soundscape composition practices. In his book, Hutchins explores an understanding of the relationship between culture and cognition, arguing that culture was marginalized in early

cognitive science and advocating an understanding of individual cognition before dealing with culture, history, and situation. He proposes that culture is a human cognitive process that takes place inside and outside people's minds and is reflected in our everyday cultural practices.(Hutchins, 1995b) Hollan, Hutchins, and Kirsh agree with this point and emphasize that the environment is a resource base for learning, problem solving, and reasoning, and that we find some of the answers to common problems in our culture, which provides us with the intellectual tools to build on what we already have. (Hollan et al., 2000) Using the trial process as an example, Norton discusses how cultural infrastructures can help with complex cognitive tasks by assigning roles, setting rules, and providing contextual information during the trial process. (Norton, 2020)

**6. Sichuan Flavor Aesthetics**

In this Chengdu soundscape composition project, I experimentally used various external tools, such as computer programs built with Max/MSP and different recording devices like various microphones. Notably, this project has a clear goal. As part of my entire PhD portfolio, the final output will be an electronic music piece with characteristics of cultural hybridity. The materials used will all come from my field recordings in Chengdu. Instead of basing a project in a more familiar city, such as my hometown of Hangzhou, I chose Chengdu, firstly because it is a city characterized by strong traditional Chinese culture. Chengdu has intangible cultural heritage such as Sichuan Opera and is one of the birthplaces of Taoist culture. In addition, Chengdu is also influenced by Tibetan culture. This makes Chengdu a city with a diverse and vibrant cultural heritage. The second reason is that I can listen to the city from the perspective of a composer or an ethnographer or just a tourist, so as to avoid overloading the piece with my personal experiences and emotions. For example, Chengdu has its own dialect and I don't understand all the meanings, so I can focus as much as possible on the sound itself and the culture behind it, rather than the meaning conveyed in the language. Boersen points out that when we leave a familiar soundscape, we lose the ability to predict the sound environment, thus encouraging our perception to shift to the development of new perceptual modalities. In other words, we listen more discriminatively when our predictive perception fails to predict our sensory environment. (Boersen, 2022) Before starting the project, I wrote a Patch in Maxmsp (Figure 1) to randomize variables, such as when, where, and how to capture sounds (after preliminary screening, the program's initial setup randomly selected one of the following 12 locations).

1) People's Park (hustle and bustle of the streets)

2) DongLiu Vegetable Market (bird market)

3) TaiKooLi (nightlife)

4) LongQuan Mountain (mountainous area)

5) Wide and Narrow Alley Ancient Town (bamboo qin, storytelling, fast-paced improvisation)

6) Wangjianglou Park (bamboo forest)

7) Jiuyan Bridge (Funan River)

8) Wenshu Monastery (temple)

9) Qingyang Palace (Taoist culture)

10) Kuanzhai Alley (busy streets)

11) Guanyin Pavilion Teahouse (Teahouse)

12) Sanhua Sichuan Opera Art Center (underground Sichuan Opera troupe).

The patch also needs to select the microphone to be used each time in the following table (Table 1) and decide whether the microphone should be placed close to a specific sound source or not close to a specific sound source. Different types of microphones with different polar patterns have their suitable recording methods, but in this experiment, a more flexible approach will be employed. If the program decides to use a cardioid microphone for ambient sound recording or an omnidirectional microphone close to the sound source, both are permitted. The purpose of setting up the program was to establish clear objectives, enabling creators to follow a relatively fixed yet randomized list, thereby enhancing the diversity of material for the work and transcending the limitations of subjective thinking by the creators.

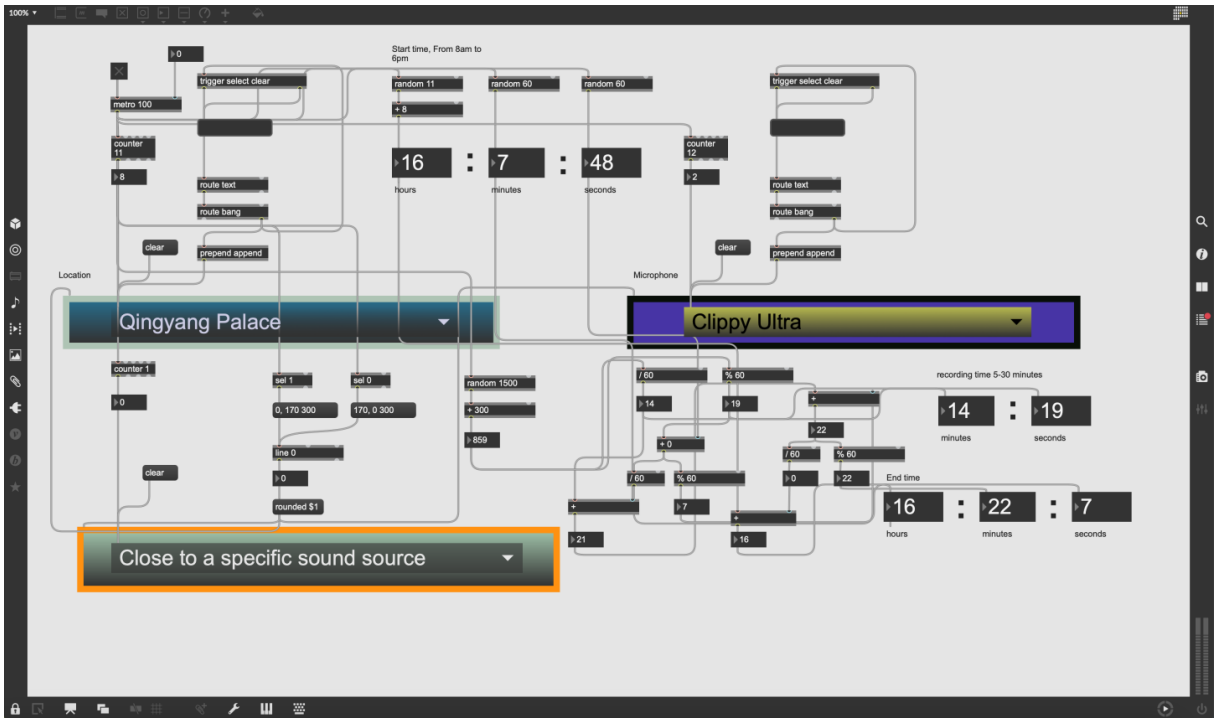


Figure 1.

Table 1. Microphone list

| Microphone Types | Brand | Model | Note |
|---|---|---|---|
| Omnidirectional | Lom | basicUcho | It is especially useful for recording delicate sounds and environments. |
| Omnidirectional | FEL Communications Ltd | Pluggy | The Pluggy uses the acclaimed Primo EM272Z1 capsule, made in Japan. |
| Ultrasonic Microphone | FEL Communications Ltd | Clippy Ultra | Frequency range 20 Hz-110 kHz. Recording of bat calls, insects, rodents and the high-frequency noises emitted by electronic equipment and engines. |
| Geophone | Lom | Geofón | Be used to capture very faint vibrations in various materials and even soil. |
| Electromagnetic sensors | Lom | Elektrouši | Used to capture electronic signals/sounds i.e., light bulbs, home appliances, etc. |
| Contact microphone | Jez Riley French | SERIES PRO+ | Large diameter element providing, in conjunction with the JrF exclusive ‘acoustic-transfer’ coating. |
| Hydrophone | Aquarian Hydrophone | C-H2D | Can be used underwater, good sensitivity, handles drops and extreme temperatures. |
| Binaural Microphone | SE3D | DIY Binaural microphone Kit | Imitate the natural way our ears pick up sounds. |
| MicroCassette Recorder | Sanyo | TRC-515M | Analog recording, can record lo-fi audio. |
| Shotgun Microphone | Sennheiser | MKE 600 | Polar pattern: Supercardioid / Lobar, more targeted. |
| Parabolic Microphones | Dodotronic | Hi-Sound Compact | Uses a parabolic reflector to collect and focus sound waves onto a transducer, can pick up distant sounds. |
| omni-directional | Lom | mikroUši Pro | Tiny size (only 6.8 mm in diameter). They are especially useful for recording delicate sounds and |

| | |
|---|---|
| electret microphones | environments. |
| Cardioid Condenser Line Audio CM4 Microphone | The linear off axis performance is beneficial with large sound sources and for stereo recording, preserving sound character at an angle. |

In this process, the program instructs individual to press the record button at specific times and places. However, this relationship is not unilateral; there is coupling between the person and the computer program. Within the times and spaces determined by the computer, individual need to draw on their familiarity with recording equipment, their experience in recording, and even their cultural background to assess which sounds are worth capturing at that particular time and place. Throughout this process, as I was influenced by the surrounding environment and the specific circumstances at the time, the plan underwent continuous modification and optimization. This evolving understanding of Chengdu's soundscapes has significantly aided me in later composing with these materials. For example, following the program's instructions, I received a command to visit Dongliu Vegetable Market (bird market) the next day and use a Geophone for recording. Upon arriving at the destination the next day, I discovered that the market was not there. I asked passersby and learned that the market only operates on Tuesdays, Thursdays, and Saturdays, whereas it was Sunday, with no market and thus no worthwhile sounds to capture (at least that's how I felt at the time). Therefore, I adjusted my plan and returned on Tuesday, equipped with a different microphone suitable for recording ambient sounds, and successfully completed the task.

Additionally, I also inquired about some memories of sounds from people who grew up in Chengdu, such as: street vendors' calls, the rhythmic sound of iron pestles making candied haws, the creaking sound of old bamboo chairs, and the sound of playing mahjong. These recordings serve as human-added supplements. Martin provided us with a feasible approach for creating soundscapes: In his work *A Bit Closer to Home* (2014), he interviewed firsthand narrators about past sounds and reproduced these sounds through recordings, with each part focusing on sounds from the narrators' childhood. The use of colloquial terms emphasizes the overall background of the work. (Martin, 2018) Although the audio recordings from these interviews were not used in this project, the process significantly aided the entire endeavor. I connected with local individuals to seek out their accounts of "sounds of the past," during which my understanding continued to evolve, and plans were continually reshaped, though the ultimate goal remained consistent. Notably, I learned of a traditional candy selling call, which was actually the sound of a vendor using a sugar-cutting knife to attract customers (especially children) while selling homemade malt candy. Despite several days of sound walking, I did not encounter any candy sellers on the streets. Upon querying local residents, many mentioned that such vendors were more prevalent in their childhood and are now rarely heard, possibly due to the intense June heat when I attempted to record. According to some, these few remaining candy sellers take a break during the hot summer months and resume sales only after October to prevent the candy from melting in the high temperatures. This completely disrupted my plans. After researching online, I found several shops selling the sugar-cutting knife (also considered a musical instrument due to its sound). Believing this sound essential to my final work, I decided to purchase one. I then learned techniques from historical records to play it myself. Eventually, I successfully recorded the sound in my hotel room, achieving the materials I desired. (Figure 2)

Figure 2.

Another example is that when I sat down to listen to a Sichuan opera at the Sanhua Sichuan Opera Art Center, due to my unfamiliarity with the local dialect, I started to wander, yet it seemed like I could no longer hear the sounds of the live Sichuan opera in my ears. But I could clearly hear the sound of the bamboo chair I was sitting on, and I was sensitive enough to realize that it was a sound that belonged to the culture (Sichuan is rich in bamboo, so many people's furniture and household utensils are made of bamboo, and the joints of these bamboo products loosen up over time, and they make a creaking sound), and that I rarely hear it anywhere else. However, the microphone I had with me on the day was a Pluggy (an Omnidirectional microphone), which meant that I could only manage to record this sound along with the ambient sound. Obviously, this wasn't the effect I was going for, I was trying to recreate the state I was in when I was spaced out, with only the sound of the chair rocking in my ears and mind. I went back to the place the next day and brought JRF's Contact microphone with me (Figure 3), which allowed me to record the purest sound of the chair vibrating, the sound that best restored my consciousness at the time.

Figure 3.

I used this material in the final piece, which starts at around 3 minutes 38 seconds, when the sound of the Sichuan Opera begins to diminish and the sound of the chair begins to grow stronger, indicating that I am gradually wandering into another dimension. The course of this experience demonstrates how my perceptions transcend individual thinking and integrate the sounds and cultural context of my environment. My sensitivity to the sound of the chair reflects how external environmental cues and objects influenced my perception and awareness, while the use of the microphone exemplifies how technological tools were important in shaping my cognitive experience and capturing the desired auditory sensations.

Human interactions are multimodal and encompass multi-resource relationships, and such interactions do not just take place in an individual's brain, but a whole system including the brain, body and shared environment is evolving. (Hutchins, 2020, p. 376)

In this soundscape composition practice, I broke down a relatively large system task into several smaller "interactive systems." For example, I planned recording tasks based on different times, locations, and the equipment needed, while making real-time adjustments and re-planning according to the circumstances. This approach ultimately led to better results and more accurately captured the sound materials I was aiming for. Hutchins argues that in cognitive science it is sometimes easier to solve seemingly complex problems than seemingly simple ones. This is because complex problems may involve multiple interacting systems, and synergies between these systems can provide more comprehensive and effective solutions. (Hutchins, 2020, p. 394-395)

When I returned from China to my home studio in Glasgow, UK with the recorded sound material to start preparing only the later stages of the composition, I realized that the recorded material was not only the sound material for my work, but also became a part of my cognition. In traditional models of cognition, working materials (e.g., tools, documents, etc.) may be seen only as external stimuli. However, in Distributed Cognition Theory, these materials are not just aids, but become part of a cognitive system that better supports the user's cognitive and practical activities. (Hollan et al., 2000) The process of editing and composing this recorded sound material for me involves human (composer) and tools (sound, computer, software, etc.), contributions, respectively, and these are distributed in a complex coupled system. Within this system, certain elements possess

multiple attributes; for instance, sound materials serve not only as crucial sources of creation but also extend the memories of the creators. Karen Pearlman's article *Documentary Editing and Distributed Cognition* explores the application of Distributed Cognition Theory to documentary editing. He emphasizes that the process is not just internal to the brain, but involves the editor, the director and the raw filmed material playing an important role in the process. He mentions that the way editing works fits well with Clark's (2015) notion of "predictive processing" and summarizes five key cognitive actions in editing *Watching, Sorting, Remembering, Selecting and Composing* to explain how cognition is distributed across the editor's brain and how it is shared between the editor's mental work and the editing tools and materials. (Pearlman, 2018) This provided me with a good inspiration when creating this piece, as soundscape composition is essentially similar to documentary filmmaking in that it is based on filmed or recorded material. By replacing Karen Pearlman's five key cognitive actions of Watching with Listening, we can obtain the five cognitive actions of Listening, Sorting, Remembering, Selecting and Composing, which can then be transferred to analyzing the cognitive processes involved in soundscape composition. Certainly, Sichuan Flavor Aesthetics does not refer to the documentary approach in its creation, but only to the framework proposed by Karen Pearlman in the analysis and understanding of distributional cognition.

## 7. Conclusion

There are precedents for applying the theory of extended mind and distributed cognition to design and even music composition, for example: Busby did a study on analyzing the practices of engineering designers in the concept selection process, experimentally interviewing 12 engineering designers and identifying 36 different practices that were analyzed for their goals and how they involved distributed cognition. how they involve distributed cognition. It was concluded that distributed cognition is prevalent and complementary to design practice, and that designers are able to utilize the resources of distributed cognition whilst maintaining control of (and not relying on) cognitive processes. However, it also acknowledges the limitations of this study, such as the absence of discussion in the experiment about how designers' cognition is affected by these levels of standardization and constraints within the design community. (Busby, 2001) It's a bit like Otto's notebook in the Clark and Chalmers example, where the notebook is not simply an external aid, but a central part of his cognitive system. In my case, the sound material is the 'notebook' that I use to compose, which is reliable for me and can be used to know what to do. Nabavian's PhD thesis research at Queen Mary, University of London, describes how distributed cognition supports a supportive and coordinated framework for Joint Music Composition. For example, distributed cognition allows information to flow freely between team members, external tools become part of the collective cognition, collaboration becomes a dynamic and interdependent process, and team members are inspired by each other's ideas (Nabavian, 2010). Although these situations are not identical, they demonstrate that distributed cognition can indeed inspire certain artistic creations or creators.

In this paper, I explore how extended mind and distributed cognition play a role in my soundscape composition *Sichuan Flavor Aesthetics.* By understanding cognitive theory, I improved my efficiency in task management and deepened my understanding of the creative process. Therefore, I am sharing my experience from this project. Additionally, assuming that distributed cognition systems could be used as an educational tool, to help analyze and understand cases, aiding learners in better grasping the management of complex relationships, the application of various techniques, and the synthesis of creative processes in soundscape composition. Admittedly, discussing soundscape composition within the framework of cognitive systems also has limitations. For instance, it may not be applicable in all situations and might only be relevant to certain specific soundscape composition practices. Additionally, it offers limited practical solutions to technical problems in composition and is primarily useful for analyzing and understanding compositional behavior. Last but not least, effectively applying or translating the theory into practice still requires further experimentation and validation.

## References

Achiam, M., May, M. and Marandino, M., (2014). Affordances and distributed cognition in museum exhibitions. *Museum Management and curatorship*, *29*(5), pp. 461-481.

Boersen, R., (2022). Enactive Listening: Perceptual reflections on soundscape composition. *Organised Sound*, *27*(1), pp. 69-79.

Button, G., (2008). Against Distributed Cognition. *Theory, Culture & Society*, *25*(2), pp. 87-104.

Busby, J.S., (2001). Practices in design concept selection as distributed cognition. *Cognition, Technology & Work*, *3*, pp. 140-149.

Cheon, H., (2014). Distributed cognition in scientific contexts. *Journal for General Philosophy of Science*, *45*, pp. 23-33.

Clark, A., (2015). *Surfing uncertainty: Prediction, action, and the embodied mind*. Oxford University Press.

Clark, A. and Chalmers, D., (1998). The extended mind. *Analysis*, *58*(1), pp. 7-19.

Drever, J.L., (2002). Soundscape composition: the convergence of ethnography and acousmatic music. *Organised Sound*, *7*(1), pp. 21-27.

Freeman, J. et al., (2011). Soundscape Composition and Field Recording as a Platform for Collaborative Creativity. *Organised Sound*, *16*(3), pp. 272-281. doi:10.1017/S1355771811000288.

Findlay-Walsh, I., (2018). Sonic Autoethnographies: Personal listening as compositional context. *Organised Sound*, *23*(1), pp. 121-130. doi:10.1017/S1355771817000371.

Findlay-Walsh, I., (2019). Hearing How It Feels to Listen: Perception, embodiment and first-person field recording. *Organised Sound*, *24*(1), pp. 30-40. doi:10.1017/S1355771819000049.

Furniss, D., Garfield, S., Husson, F., Blandford, A. and Franklin, B.D., (2019). Distributed cognition: understanding complex sociotechnical informatics. *Applied Interdisciplinary Theory in Health Informatics*, pp. 75-86.

Gibbs Jr, R.W., (2005). *Embodiment and cognitive science*. Cambridge University Press.

Giere, R.N., (2007). Distributed cognition without distributed knowing. *Social epistemology*, *21*(3), pp. 313-320.

Halverson, C.A., (1995). Inside the Cognitive Workplace: New Technology and Air Traffic Control. PhD Thesis, Dept. of Cognitive Science, University of California San Diego.

Hazlehurst, B., Gorman, P.N. and McMullen, C.K., (2008). Distributed cognition: an alternative model of cognition for medical informatics. *International journal of medical informatics*, *77*(4), pp. 226-234.

Hollan, J., Hutchins, E. and Kirsh, D., (2000). Distributed cognition: toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *7*(2), pp. 174-196.

Hutchins, E., (1995a). How a cockpit remembers its speeds. *Cognitive science*, *19*(3), pp. 265-288.

Hutchins, E., (1995b). *Cognition in the Wild*. MIT press.

Hutchins, E., (2013). The cultural ecosystem of human cognition. *Philosophical Psychology*, *27(*1), pp. 34-49. doi: 10.1080/09515089.2013.830548.

Hutchins, E., (2020). The distributed cognition perspective on human interaction. In Roots of human sociality (pp. 375-398). Routledge.

Karasavvidis, I., (2002). Distributed cognition and educational practice. *Journal of interactive learning research*, *13*(1), pp. 11-29.

Kelder, J. and Turner, P., (2004). In the eye of the storm: the role of distributed cognition theory for informing the design of meteorological information system. In *ISOneWorld Conference-April* (pp. 14-16).

Keller, J.D., (1996). *Review Symposium: Cognition in the Wild*. E. Hutchins. Cambridge, MA: MIT Press, pp. 381.

Kirsh, D. and Maglio, P., (1994). On distinguishing epistemic from pragmatic action. *Cognitive science*, *18*(4), pp. 513-549.

Levack Drever, J., (2002). Soundscape composition: the convergence of ethnography and acousmatic music. *Organised Sound*, *7*(1), pp. 21-27. doi:10.1017/S1355771802001048.

Magnus, P.D., (2007). Distributed cognition and the task of science. *Social Studies of Science*, *37*(2), pp. 297-310.

Martin, B., (2018). Soundscape Composition: Enhancing our understanding of changing soundscapes. *Organised Sound*, *23*(1), pp. 20-28.

Michaelian, K. and Sutton, J., (2013). Distributed cognition and memory research: History and current directions. *Review of philosophy and psychology*, *4*, pp. 1-24.

Nabavian, S., (2010). Distributed cognition in joint music composition: Exploring the role of language and artefacts in multi-session creative collaborative work (Doctoral dissertation, Queen Mary University of London).

Norton, M., (2020). Cultural sociology meets the cognitive wild: advantages of the distributed cognition framework for analyzing the intersection of culture and cognition. *American Journal of Cultural Sociology*, *8*(1), pp. 45-62.

Pearlman, K., (2018). Documentary editing and distributed cognition. *Cognitive theory and documentary film*, pp. 303-319.

Perry, M., (2003). Distributed cognition. *HCI models, theories, and frameworks: Toward a multidisciplinary science*, pp. 193-223.

Rogers, Y., (1992). December. Ghosts in the network: distributed troubleshooting in a shared working environment. In *Proceedings of the 1992 ACM conference on Computer-supported cooperative work* (pp. 346-355).

Rogers, Y., (1993). Coordinating computer-mediated work. *Computer Supported Cooperative Work (CSCW)*, *1*, pp. 295-315.

Rupert, R.D., (2009). *Cognitive systems and the extended mind*. Oxford University Press.

Schafer, R.M., (1993). *The soundscape: Our sonic environment and the tuning of the world*. Simon and Schuster.

Truax, B., (1984). *Acoustic Communication*. Norwood, NJ: Ablex Publishing Corporation. 2nd edition, 2001.

Truax, B., (1996). Soundscape, acoustic communication & environmental sound composition. *Contemporary Music Review*, *15*(1), 49-65.

Truax, B., (2000). The aesthetics of computer music: a questionable concept reconsidered. *Organised Sound*, *5*(3), 119-26.

Truax, B., (2002). Genres and techniques of soundscape composition as developed at Simon Fraser University. *Organised sound*, *7*(1), pp. 5-14.

Walker, G.H., Stanton, N.A., Baber, C., Wells, L., Gibson, H., Salmon, P. and Jenkins, D., (2010). From ethnography to the EAST method: A tractable approach for representing distributed cognition in Air Traffic Control. *Ergonomics*, *53*(2), pp. 184-197.