

**MUSIC, VIBROTACTILE MEDIATION AND BODILY  
SENSATIONS IN ANOREXIA NERVOSA:  
“IT’S LIKE I CAN REALLY FEEL MY HEART BEATING”**

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**Abstract:** *This article presents the theoretical, scientific, and methodological foundations for the design and implementation of an innovative technological and clinical platform that combined sound, music, and vibrotactile mediation used in a therapeutic setting by adolescents suffering from anorexia nervosa. In 2019, we carried out a pilot experiment with a group of 8 adolescent patients hospitalized in the Eating Disorders Unit of the Department of Adolescent and Young Adult Psychiatry of the Institut Mutualiste Montsouris in Paris. Within this clinical framework, we aimed to create conditions suitable for patients to*

*reinvest in their “disaffected” bodily zones and internal experiences through reflecting on the sensations, emotions, and ideas generated by the sensory experiences created when sound and musical stimuli are transmitted through vibrations. The findings demonstrate the ways in which adolescent patients made use of the platform’s audiovibrotactile mediating objects to express a personal associative process through speech during their exchanges with clinical psychologists.*

**Keywords:** *music, vibrations, therapy, anorexia, body, emotions.*

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## INTRODUCTION

This article presents the design and creation of an original mediation framework combining sound, music, and vibrotactile stimuli to aid in the treatment of adolescents suffering from anorexia nervosa, part of the “eating disorders” category of the DSM-5.<sup>1</sup> In 2019, we conducted a sound, music, and vibrotactile mediation workshop over five sessions to support adolescents hospitalized for anorexia within the Eating Disorders Service of the Adolescent and Young Adult Department of Psychiatry at the Institut Mutualiste Montsouris (IMM) in Paris.

### The Problem of Anorexia Nervosa

Among young persons affected by an eating disorder, particularly those who develop anorexia nervosa during adolescence, the profound physical and mental transformations of puberty can result in dependency issues. At a time when the individual is tackling the process of mourning his/her childhood and starting on the path of adolescence, a largely unconscious struggle arises regarding the internalization process of separation from his/her parents (Jeammet & Corcos, 2010; Kaplan, 1984/1995). In this context, an eating disorder can function as a defense against internal and external strains. The young subject tends to create relationships of dependence with objects in the outside world, particularly in the form of deprivation or excessive feeding. The subject also overinvests in the world of perception and motor action, while simultaneously trying to maintain strict control over his/her own bodily sensations and functions. Control of the mouth and the digestive apparatus can be overemphasized, to the detriment of the other zones of the body, as well as the relationship with others, which then become “disaffected” or disinvested affectively, emotionally, and representationally (Corcos, 2008, 2011; Kestemberg, Kestemberg, & Decobert, 2005; McDougall, 1989). The excessive physical activity and demand for powerful sensations—as well as the desensitized, seemingly abandoned, body—can be understood as forms of defense against the affect that threatens to overwhelm the adolescent. The symptoms of dependence and control emerge at the cost of the subject’s relationship to his/her inner psychic life (i.e., sensations, profound affect, emotions, ideas), which also is experienced as threatening. Working with these patients, therefore, means helping them reappropriate their inner experience and emotions so that they gradually become capable of reinvesting in their psychic life and an affective relationship with others (Logak & Barbosa, 2016).

### Obstacles to Therapy

Clinicians frequently are challenged with the difficult process of constructing a therapeutic alliance with a patient who regularly attacks relationships and struggles to verbally engage in the process of association (Lindenmeyer, 2019). The process of association indicates the successive connections produced by the subject among his/her emotionally charged psychic representations (Freud, 1895/1950). Given these challenges, what type of therapeutic work can a clinician offer to open a possible pathway? In the field of clinical work with anorexia patients, various mediation alternatives have been explored since the 1950s. Some of these mediation practices have been consolidated and/or diversified in recent decades (Brun, Chouvier, & Roussillon, 2019; Corcos, Gumy, & Loisel, 2019). Among the various techniques explored has been the therapeutic process of using music, dance, massage, balneotherapy, and painting as mediating supports.

In this perspective, we questioned whether an original clinical framework of bodily and artistic practice adapted to these young patients could overcome these therapeutic challenges. Thus, in an exploratory study with eight participants, we implemented an innovative mediation platform to assist in the therapeutic treatment of adolescent anorexic patients by generating profound bodily sensations through sound and music vibrations conveyed via various mediating objects. The design and implementation of this platform resulted from a collaborative and interdisciplinary vision. Our general research question was whether this mediation platform could lead anorexia patients to explore their bodily sensations and verbalize their inner experiences. Explicitly, then, how would these patients come into contact with the mediating objects and express their relationships to these objects? How would they use the sounds, and what types of representation and affect would they express in relation to these sounds? Would these sounds arouse in the patients any representations and emotions linked to their past and current experiences? Moreover, would this mediation platform reveal important contents of patients' psychic lives, which possibly could be elaborated in a full therapeutic process?

The goal of our study was to encourage patients to explore their bodily sensations and perhaps express the affect and ideas generated by these feelings during their discursive exchanges with two psychologists. Given the exploratory nature of the study, our two hypotheses were deliberately broad. Based on previous research work on mediation practices, especially in the therapeutic treatment of anorexia, our main assumption was that the bodily sensations generated by our technological devices in the clinical context would mobilize affect, emotions, and representations (Brun et al., 2019; Corcos et al., 2019; Hypothesis 1). Expressing bodily sensations and associative processes verbally represents an important step for patients that subsequently can be elaborated in a specific therapeutic setting, one distinct from the mediation platform. We expected to find signs of these associative processes in the patients' expressions, both verbal and nonverbal: observed behavior and utterances referring not only to immediate bodily sensations but also to the ideas, personal experiences, and emotions linked to them (Hypothesis 2). In the Methods section, we formulate some additional hypotheses on the potential function of sound excerpts and mediating objects for patients. These additional hypotheses oriented the design of the platform but are outside the scope of this particular paper.

### **Music, New Technologies, and Vibrotactile Mediation**

Thanks to its specific properties and methods, music is a field of experience and practice greatly suited to therapeutic work. Some authors have pointed out that a musical experience is fundamentally embodied and emotional (Cox, 2016; Sacks, 2007). Experiencing music, both its production and reception, requires and sustains the subject's bodily engagement in terms of feelings and various modes of motor activity. Likewise, musical experience awakens and mobilizes affect, from which it typically cannot be dissociated. According to the musicologist Arnie Cox (2016, p. 177), affect in music includes "everything that might be described in terms of feeling, including emotions, moods, desires, and urges, as well as the feelings of exertions, balance, alertness, warmth, and other sensory experiences ... Musical affect is a special case of affective life generally: every experience has an affective dimension, which is simply what an experience feels like, or 'the feeling of what happens.'"

Moreover, psychologists, psychiatrists, and psychoanalysts have shown that musical experience is rooted in an infant's first sensory and affective experiences and in his/her

relationships with others and the surrounding environment. This musical experience specifically relates to the rhythms, intonations, and melodies transmitted to him/her by others at an early stage and through which the infant learns to move his/her body, giving form to ongoing muscular effort (Didier-Weill, 1995, 1998). On the other hand, the phenomenon of sound and music is dynamic and evanescent: It arises, unfolds, and ceases after a variable period of time, leaving behind mnesic (psychosomatic) traces within the subject and reactivating former traces, some of them related to early experiences. From the perspective of subjective experience, music can be remembered or transformed, especially because of modern recording techniques and digital media. In therapeutic work, therefore, music becomes a highly plastic experiential object (Pankow, 1977).

In its multimodal and embodied aspects, receiving music through vibrations seems particularly relevant when working with anorexic patients because sound waves can be “touched” and, in turn, touch the subject’s body profoundly and extensively. According to Merleau-Ponty, “All tactile perception, while opening itself to an objective ‘property’, includes a bodily component: the tactile localisation of an object, for example, assigns to it its place in relation to the cardinal points of the body image” (1945/2002, p. 370). Further, Merleau-Ponty wrote that “to touch is to touch oneself ... The touching oneself and the touching have to be understood as each the reverse of the other” (1964/1968, p. 255). We argue that the phenomenological reversibility of “touching/touching oneself” echoes the psychic reversibility of “touching/being touched,” following the connections between the activity and passivity characteristics of the drive (Freud, 1915/1957).

The vibrotactile modality forms a specific part of the general sense of touch, which is the first sense connecting the human fetus to the mother’s body and, through her, to the environment (Golse, 2010). This first fetal sense usually falls into the perceptive background with the appearance of hearing and sight later in development. However, it remains fundamental to the experience of one’s own body, of others, and the world (Fröhlich, 2000; Merleau-Ponty, 1945/2002). The concept of the “skin ego,” developed by the psychoanalyst Didier Anzieu, aimed to account for the role of skin in the psychic construction of the ego. This development mainly forms from the contact with the mother’s body and the “sound envelope,” a feeling created specifically by the early experience of the mother’s voice among other surrounding sounds (Anzieu, 1985/2016). In fact, the phenomenon of vibration, even though it is accessed through the skin, reaches deep parts of the entire body (i.e., the musculature, skeleton, and internal organs).

New technologies have altered contemporary musical practices significantly, as evidenced by the boom in artistic performances, activities, and computer-music training courses (Genevois & de Vivo, 1999). Alongside the development of new digital tools, growth is apparent over the past decade in the amount of scientific and technical research on the perception of vibrations in the field of musical experience (e.g., Gandhi, Sesek, Tuckett, & Bamberg, 2011; Giordano & Wanderley, 2015; Hopkins, Maté-Cid, Fulford, Seiffert, & Ginsborg, 2016; Merchel & Altinsoy, 2013; Wollman, Fritz, & Frelat, 2015). The results have concerned primarily persons with hearing or visual impairment and have been used in different ways, for example, to aid in everyday activities, leisure or education, art, and therapy. In Europe, particularly in Norway, Finland, and England, vibroacoustic methods have been used in music therapy since the 1980s to improve somatic and mental disorders (Jacobsen, Pedersen, & Bonde 2019; Skille, 1989). A qualitative research based on “vibroacoustic therapy” was carried out in Estonia with adolescent girls suffering from heightened anxiety combined with low self-esteem and/or body image

problems (Rüütel, Ratnik, Tamm, & Zilensk, 2004). This experiment intended to enhance the young people's ability to cope with stress through relaxation and positive bodily experiences. In general, new technologies and their present-day practices have transformed indeed the processes of the subjective construction of bodily experience. Thanks to their potential in terms of the synthesis, editing, recording, broadcasting, and real-time transformation of sound, new digital tools offer unprecedented possibilities of exploring the emotions and representations linked to the bodily sensations provoked by sound and musical events (stimuli). In this way, the research carried out in this area of clinical work can be expanded for and adapted to other forms of mental distress.

In this context, the bodily mediation framework we designed had a number of specificities. First, the vibration was not an independent stimulus associated with the sound and music event; rather, it was directly generated by it. Second, patients with anorexia could actively play with and transform music in real-time through the digital tools. Third, they could explore sound and music vibrations through their body contact with “mediating objects” made of various materials. In this way, the framework transformed the reception of sounds and music through vibrating mediating objects that the patient could invest in (Brun, 2019). Additionally, the presence of two psychologists was key in creating a situation that functioned as a mediator between the patient's internal and external worlds. One psychologist played a restrained active role with patients, while the other took on an observation-based role with limited possibilities of interaction. We will specify in the Methods section the experiment setup, the roles of psychologists, and the instructions given to the patients. From a psychoanalytic perspective, our framework aims to encourage the patient to engage in a process of association and verbal expression of his/her deep inner experiences, based on his/her bodily sensations.

We ground our current research in three previous experiments. First, Hugues Genevois and Errika Manta carried out in 2012 a vibrotactile exploration experiment with Θέατρο Κωφών Ελλάδος [Greek Deaf Theatre], a sign-language theatre company based in Athens, in coordination with the group's interpreter and facilitator, Sophia Roboli. This experiment demonstrated the importance of one's relationship toward the social other in the construction of the perception of vibrotactile stimulation.

Second, Hugues Genevois developed a “sound table” and other Max-based digital tools<sup>2</sup> for the *Histoires sensibles* project. This vibrasonorous pedagogic experiment, carried out in 2012–2013, was designed by the French composer Pascale Criton and Elsa Falcucci, a lecturer at the National Institute for Deaf Youth. The experiment was intended primarily for deaf students but also included mixed audiences with different sensory conditions (hearing, deaf, sighted, or blind). It showed that the reception of vibrotactile signals, although seemingly intuitive and immediate, requires a certain level of learning by the subject to consciously elaborate his/her bodily sensations through technological devices (Criton, 2014; Criton, Genevois, Falcucci, & Patiño-Lakatos, 2014; Patiño-Lakatos, 2015).

Third, in 2015, Gabriela Patiño-Lakatos, Benoît Navarret and Hugues Genevois carried out an empirical study looking at the perception of vibration signals transmitted via a prototype vibrotactile bracelet designed by Genevois.<sup>3</sup> This prototype used a transducer (i.e., Dayton Audio 13 mm 8 ohms NXT) controlled through an amplifier by software that synthesized and transformed signals in real time (Max). The experiment involved 10 subjects presenting various sensory conditions: 6 nonimpaired men, a nonimpaired woman, a blind man, a visually impaired man, and a hearing-impaired woman. Throughout four stages, the participants expressed their perception of the vibrotactile signals from the bracelet worn on the wrist of

their dominant arm. This experiment resulted in a better understanding of the meaning and possible communication functions of vibrotactile signals in the context of collective play for shared musical practice (Patiño-Lakatos, Navarret, & Genevois, 2019, 2020). Moreover, it showed that participants possessed significant potential to detect consciously, differentiate, and recognize vibration signals. They could organize their perceptions into categories according to their sensory situation, as well as their personal and professional backgrounds. Indeed, as the sense of touch is generally little educated in an explicit and conscious manner, the verbal description of vibrotactile perception was an unusual and astonishing situation for the subjects. Therefore, we concluded, a vibrotactile event mobilizes the recall of personal experiences and metaphorical language.

Taken together, these three previous studies demonstrate the relevance of vibrotactile mediation for the subjective construction of bodily sensations. Yet we believe additional benefits remain unknown.

## METHODS

### Sample

During a 2-month period, we conducted an experiment with eight patients—one boy and seven girls—aged 14–19 years and hospitalized with the symptoms of either the restricting or restricting–purging types of anorexia nervosa. All had a body mass index of 14–18 (kg.m<sup>-2</sup>). We used the diagnostic criteria of anorexia nervosa established by the DSM-5. The patients were hospitalized in the Adolescent and Young Adult Department of Psychiatry of the IMM for between 3 and 10 months. After reading and signing the information and consent form, patients were free to either accept or refuse taking part in the workshop without any impact on their usual medical treatment at the institute. This project was approved by the Ethics Committee of the University of Paris: CER-PD: 2019-39-BARBOSA.

### Workshop Setting

We implemented the mediation platform in collaboration with the clinical team of the institution responsible for patient care. We first presented to the psychiatrists, who spoke to their patients about the possibility of participating in this experiment. The platform was designed as a workshop, similar to the usual mediation activities offered at the IMM. The workshop involved a short research experiment in a therapeutic context in order to test the mediation platform as a support for a full therapy process. Two clinical psychologists among us conducted the workshop—they are coauthors of this paper. The psychologists were not on the staff of the IMM nor worked with the patients in the institution.

The workshop took place in a room at IMM dedicated to the installation. The psychologists conducted five individual workshop sessions with each patient, at a frequency of one session per week. Each session included a 30-minute exploration time followed by a 20-minute discussion with both psychologists attending. One of the psychologists, always the same person, contacted all the patients in the institution and brought them into the workshop room for each session. The other psychologist was always present in the room when the patient arrived. The patient and the

psychologists would take off their shoes before starting the workshop session; this instruction was meant to create a welcoming setting that would mark the transition between outside and inside, between before and after, with respect to the time and space of the workshop. In the first session, one of the psychologists introduced the platform to the patient, but she described neither the sounds nor the possible uses of the mediating objects (see below the description of sounds and mediating objects). At the beginning of each session, one psychologist—again, always the same person—gave the patient the following instruction: “You can do anything you like as long as you take care of the objects.” The patient would then be able to freely explore the objects and express his/her associations in a verbal exchange with the psychologists. In addition to the patients’ free speech, three open projective-type questions were asked systematically at the end of each session: What did you feel? Which of the sounds and objects were the most interesting to you? What did they make you think of? The patients’ comments throughout the workshop sessions and their final responses were written down by the observer psychologist (always the same one) who is trained for this task.

The presence of two psychologists in the workshop sessions followed the clinical requirements of this study, based on the importance of maintaining a frame of human contact rather than leaving the patient alone with the objects. From a clinical point of view, it was essential that this type of platform is led by professionals trained to recognize and explore unconscious processes with patients. The interventions of the psychologists were restricted to giving instructions regarding the workshop, providing a reassuring, containing presence—akin to the function of holding (Winnicott, 1971a)—and stimulating the vibrasorous play and the patient’s verbal associations. Their presence fulfilled a containing function insofar as they supported the patients by intervening only in what was necessary to facilitate the experience. The goal was not to engage in a therapeutic process as such but encourage (or, occasionally, refocus) the patient in the options within the workshop space. Moreover, the functions of the psychologists were differentiated with respect to the patients. One psychologist was responsible for a more active discursive exchange with the patient; the other served a more distant function as an observer, interacting with the patient only periodically by asking questions about his/her sensory experience with stimuli and objects, as well as responding to specific requests or making suggestions depending on the patient’s situation. Second, two psychologists were necessary to the research protocol: The use of patient recordings in a clinical setting with vulnerable adolescents is a sensitive issue and we were not able to use recording devices. Thus, to obtain detail from the events within each workshop, one psychologist was responsible specifically for observing and taking accurate notes on what happened and what was said during each session. She noted the patient’s speech and use and duration of the contact with the objects (timing and verbatim). This technique introduced a limitation in the data collection. Therefore, in addition to the notes taken during the session by the observing psychologist, both psychologists would transcribe and compare their observations at the end of the session. This two-step procedure was implemented to control possible biases (e.g., omission and interpretation) in data collection by the researchers.

### **Mediating Objects: Sound, Music, Contact, and Vibration Media**

The sound, music, and vibrotactile mediation framework we designed comprised 16 audiovibrotactile stimuli as well as several devices—four audiovibrotactile mediating objects, two microphones, a

gesture control MIDI interface, a computer, a software tool, a mixing console, and an amplifier. We describe the features and functions of both the stimuli and the devices in the following subsections.

## Stimuli

In previous studies, we observed the semiotic and sensory-feedback properties of a vibrotactile stimulus as part of our research on the use of digital interfaces in musical practice, auditory supplementation, and the sharing of a new type of “sensory listening.” In a 2015 study (Patiño-Lakatos et al., 2019, 2020), the stimuli were speech, complex composed sounds (i.e., musical excerpts), or basic sounds (pulse-like patterns, drone effects, and homogeneous tone colors) used to evaluate sensory thresholds (frequency and dynamic range sensibilities). In the current study, the patients could experience the sound and music both auditorily and vibrotactilely. They had a tactile experience of sound and music stimuli through body contact with the vibrating objects, as the technical system converted sound signals to vibrations. Simultaneously, the actual audio component was available in the stimuli, as the various vibrating objects functioned like loudspeakers, producing an aerial acoustic radiation of the sound. Thus, the patients could clearly hear the sound of the stimuli in an auditory way, without necessarily entering into physical contact with the vibrating objects.

Unlike previous studies, the present research was carried out in a clinical setting, that is, not in a purely artistic context. The stimuli were chosen with regard to the characteristics of patients hospitalized for eating disorders and based on information provided by Professor Dr. Maurice Corcos and his team at IMM. In this sense, we formulated a series of additional hypotheses on the possible psychological functions of different types of stimuli. Some sound stimuli were familiar (e.g., soundscapes, soundscenes from everyday life, a heartbeat) in order to induce a sense of relief or control (Hypothesis 3). Previous work on the psychosomatic approach suggest that familiar sounds have a containing function in that they underpin a sense of continuity and sharing in the lived experience (Baruch, 2009; Lauras-Petit, 2009). Other stimuli were abstract sounds, such as unidentifiable musical instruments and less common musical languages (e.g., a composition process based on writing *sounds* rather than writing *notes*). Our assumption was that abstraction could generate emotional states through the effect of surprise, leading to a renewed interest and encouraging patients to express their unique personal imagery and deep inner experiences (Hypothesis 4). The final, more involved, stimulus comprised vocal sounds captured during the sessions by two handheld microphones, one for the patient, another one for the interacting clinician. Patients could speak and explore their own voice while fully in control of the sound production process (e.g., intensity of sound, duration, meaning, sensations). Thus, their voices were emitted from inside their bodies and then returned to them from the outside, auditorily and vibrotactilely, through the vibrotactile objects: This can be described as an audiovibrotactile feedback (see below). As for the interacting clinician (always the same one), she could invite patients to speak with her or play with her voice as part of their experience. Patients also could feel the vibrations of the clinician’s voice through the audiovibrotactile feedback. Following the work of Didier Anzieu on the sound envelope, we assumed that the audiovibrotactile sensation of the voice could trigger representations and affect related to the construction of patients’ body and psyche (Hypothesis 5). Furthermore, the range of therapies provided at the IMM includes massage therapy and “packing” therapy<sup>4</sup> (Corcos et al., 2019) as ways of satisfying the need for an

envelope felt by certain patients. We took these patients' needs into consideration in our selection of the stimuli, assuming that some of them could satisfy this need (Hypothesis 6), and in the design of the vibrotactile objects (see below).

The technical configuration of the entire clinical framework presented two additional unique features that affected the patients' sensory experience, both while exploring and manipulating the stimuli and in reflecting on their experiences. First, complex sensory experience can arise from both vibrotactile and auditive perceptions because some of the vibrating objects produce enough acoustic radiation to result in audible sounds—especially the wooden table and the foam ball. In this sense, we could describe these objects as audiovibrotactile.<sup>5</sup> The range of frequencies they are able to reproduce makes it possible to both hear vibrations and feel them through the body. Secondly, various designs of the vibrating objects can induce complementary perceptive modalities, meaning that, depending on the transmitting object, a single stimulus can potentially produce different sensations.

We selected and edited 16 sound and music sequences (each music sequence is an excerpt of a larger work), looking at their potential to elicit physical and psychic sensations that encourage free-association and subjective interpretation (Table 1). Eight sound sequences evoked natural or industrial environments, whereas the remaining eight were pieces of music played in a particular context. These comprised rhythmic sequences of impulse-like signals whose dynamic envelope could be identified based on the instruments or lesser known acousmatic music compositions. This variety of stimuli was intended to allow patients to choose from and interact with a variety of sounds. In addition, the corpus of stimuli remained strictly the same from session to session with each patient. We therefore could observe changes in listening and practices over time.

### Audiovibrotactile Mediating Objects

We developed four audiovibrotactile mediating devices: a low, oval-shaped wooden table (length: 47 in. [119.4 cm]/width: 23.5 in. [59.7 cm]/height: 14 in. [35.6 cm]), a medium-sized foam ball (diameter: 8 in. [20.3 cm]), a headrest pillow (width: 12 in. [30.5 cm]) and a blanket (originally measuring 59 in. x 90.5 in. [150 x 230 cm] but folded in half and sewn to a size of 29.5 in. x 90.5 in. [75 x 230 cm]). These devices served as media to transmit to the adolescents the vibrotactile stimuli induced by sound and music. Each item offered various kinds of contact with the vibratory phenomenon and enabled us to study the different relationships with the objects in which patients can engage. We formulated, as follows, a series of additional hypotheses on the possible psychological functions of these devices.

First, the table is a hard, semifixed mediating object used previously in experiments with children and adolescents. It is symbolically associated not just with eating—and thus with food as an object—but also with social sharing and exchange. As an object evocative of community and communion, the table fosters the mediated relationship to the other and the communication of bodily sensations around a shared object. In our framework, we deliberately opted for a low, oval-shaped table, which is more ambiguous and less determined by cultural conventions than the rectangular shape that frequently functions as a dining table. This object can also fulfill the supporting function of a table-bench, on which the patient can, if he/she chooses, rest or sit down, lie down, or stand (Hypothesis 7). Second, the medium-sized headrest pillow is a soft mediating object, the style of which usually allows the patient to wear it around his/her neck and encourages relaxation (Hypothesis 8). However, because of its shape and texture, it can be placed on or held

**Table 1.** The 16 Edited Sound and Music Stimuli Used in the Mediation Platform with Hospitalized Adolescent Anorexia Nervosa Patients.

<b>SOUND STIMULI</b>	
1	Water flow (BBC, n.d.d)
2	Water waves (BBC, 1981)
3	Wind and sandstorm (BBC, n.d.a)
4	Footsteps on grass (BBC, n.d.b)
5	Human heartbeat (BBC, n.d.c)
6	Steam locomotive (excerpt, Schaeffer, 1948/2010a, CD 1, track 1)
7	Water drops (Genevois, 2019) <sup>6</sup>
8	Bubbling water (Genevois, 2019)
<b>MUSIC STIMULI</b>	
9	Traditional music of Bali (Sentana, 1991, track 4)
10	Traditional music of Benin (Rouget, 1990)
11	“Bilude” (Schaeffer, 1979/2010c, CD 3, track 17)
12	“De Natura Sonorum” (Parmegiani, 1974/2008, CD 5, track 9)
13	“Étude aux Tourniquets” (Schaeffer, 1948/2010b, CD 1, track 2)
14	“Pacific Tubular Waves” (Redolfi, 1979/1988, track 6)
15	“Presque Rien N°1” (Ferrari, 1970/2009a, CD 3, track 1)
16	“Presque Rien N°4” (Ferrari, 1990–1998/2009b, CD 3, track 9)

*Note.* The parenthetical information indicates the source or creator of each stimulus.

against the body in various other ways. Third, the cotton blanket is a flexible and enveloping object, fulfilling a containing and intimate psychic function (Anzieu, 1985/2016; Bion, 1962; Winnicott, 1971a; Hypothesis 9). Lastly, the ball is a round and mobile mediating object, soft but firmer than the headrest pillow. As such, the ball supports the functions of control, of grasping, manipulating, and moving with the hands in relation to other parts of the body, such as the chest, face, stomach, or legs (Hypothesis 10).

In order for these objects to function as an audiovibrotactile mediating device, they needed to be fitted with specific technology. We therefore employed transducers to transmit the sounds through the mediating objects. These transducers function rather like loudspeakers: They receive an audio signal through a Behringer NX1000D amplifier. For technical reasons that involve,

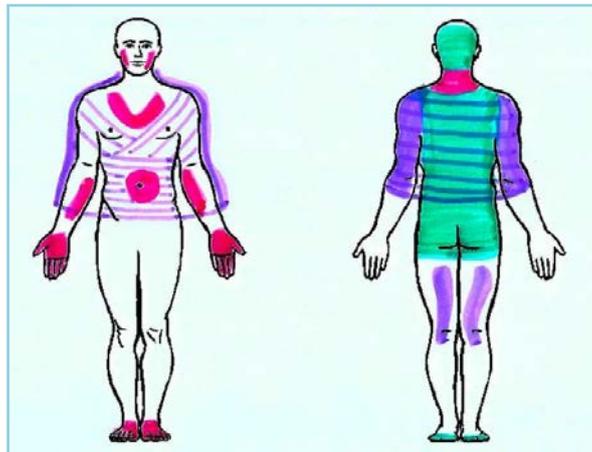
among other things, the density of the vibrating objects, we used two types of transducers in the installation. We affixed a Clark Synthesis TST329, a bigger and more powerful unit, under the table. Then, several Dayton Audio DAEX25FHEs were embedded in the other objects: four in the blanket, three in the headrest pillow and one in the ball.

Each object—including the two hand microphones—was placed inside a space delimited by a carpet (Figure 1), which the patient would enter. We considered this material, albeit soft, a demarcation of the object exploration space that was clinically relevant to symbolically institute the frame and the limits of a “playing” setting for the patients (Winnicott, 1971a). Establishing such parameters also helped to spatially differentiate the positions of the patients and psychologists during the workshop sessions. The two psychologists remained half-way across the room, outside the frame delimited by the carpet, although they could sometimes enter the space to modify something, provide support, or help the patient continue.

The elements of music and sound transmitted by these mediating objects encouraged exploration without necessarily calling upon pre-established interpretations. Instead, they were intended to stimulate the patient’s associative process while taking bodily sensations as a starting point. By engaging various parts of the body—such as the upper and lower limbs, back, neck, torso and face—we expected this framework to elicit a reinvestment of the body regions that previously have been disinvested defensively by these young anorexic patients, that is, areas other than the mouth and the digestive tract (Figure 2). In this way, the technological tools used in the body mediation framework could bring to light free associations between (a) sound and music, (b) bodily sensations originating through touch, and (c) the events of the patient’s life history.



**Figure 1.** The mediating objects placed inside the framework space, delimited by a carpet. Other materials for the patients’ use were included.



**Figure 2.** Body zones affected by contact with the framework's mediating objects. Colors represent the body contact of the mediating objects except the microphone: blanket (purple), table (green), ball, and/or headrest pillow (fuchsia).

### Technical Installation and the Software Tool

The installation was controlled by a software tool developed at LAM (Lutheries-Acoustique-Musique [Lutheries-Acoustics-Music]) and used the Max programming language. This software enabled the transmission of a selection of sound sequences and musical excerpts to the four audiovibrotactile objects. To do this, we provided the patients with a Korg NanoKontrol2 MIDI<sup>7</sup> interface that allowed them to control the sensory aspects of the vibrations and sounds, such as intensity level and playback speed (Figure 3). This MIDI interface sent commands from the patient



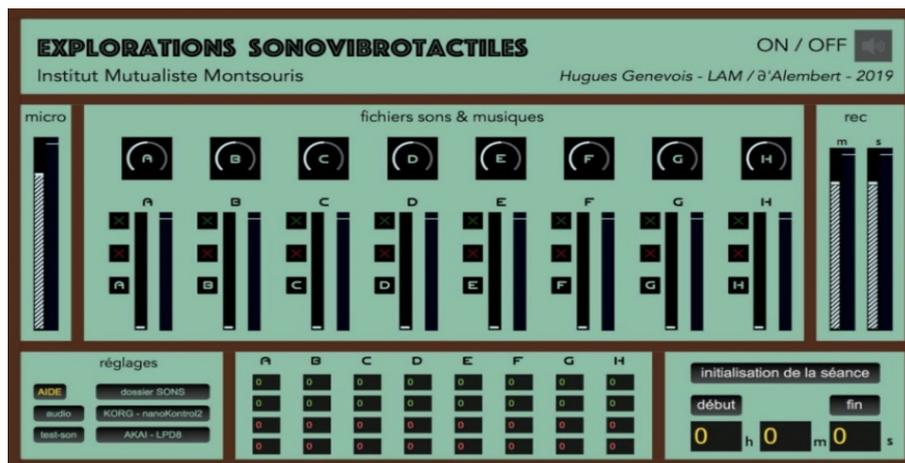
**Figure 3.** The MIDI interface allowed patients to manually control the stimuli, both the choice of sound and the character of that sound (i.e., sound level and speed).

to the computer via a USB interface. A small mixing console (Behringer Xenys 1204USB) functioned as a digital–analog converter and fed the various mediating devices via a multichannel amplifier. It also powered the microphones during the sessions. For the purposes of analysis, the software tool recorded the patients’ choices of sounds and the subsequent audio signal transmitted to the mediating objects (Figure 4).

Stimuli were activated almost exclusively by the patients, who had constant control over the MIDI interface. If the patients asked the clinician to select or modify stimuli for them, they could give access to the interface to the by placing it outside the carpet, which was a clinically significant



(a)



(b)

**Figure 4.** The technical installation components (a) of the framework for audiovibrotactile interaction by anorexia patients via mediating objects. Item (b) provides a closer image of the software tool.

action. The length of the cables connecting the devices to the computer and amplifier was sufficient to allow for these movements. All mediating objects were permanently activated and it was not possible to disconnect them during a session. Patients could choose the objects through which they wanted to explore stimuli. In this sense, the gesture control MIDI interface allowed them to personally manipulate the mediating objects and vibrasorous phenomena in order to modulate their own bodily sensations. Using the MIDI interface to gesturally control the sound vibrations and music meant that the subject must assume, psychically and corporeally, the position of the agent—that is, to avoid passively receiving stimuli from the outside—in order to modulate his/her sensations based on his/her experience. This possibility of modulation transforms the vibration and sound elements into plastic objects (Pankow, 1977).<sup>8</sup> For anorexic patients, what is at stake is being able to modulate the bodily sensations that produce anxiety: The deep connections with the human drives are difficult to contain yet without having to use control as a defense to detach from the drives completely. This therapeutic mediation framework, therefore, helps the adolescent find a balance between staying in control and letting go when experiencing these sensations.

### **Data Systematization and Analysis**

The observing psychologist took verbatim notes of patients' speech during the workshop sessions, both their free comments during exploration time and their responses to the final questions. The observing psychologist took notes also of patients' behavior related to selected sounds, as well as the use and duration of the contact with the objects (description and timing with chronometer). She noted body postures when the patients entered in contact with the objects. These notes of patients' speech and behavior were systematized, that is, coded and quantified. The patients' body contacts with each mediating object were counted and their body postures with these objects were classified and counted. The patients' verbal utterances were numbered. The total number of sentences uttered directly referring to the sounds (all sessions and all patients together) were classified by sound stimuli. For each sentence, the significant semantic units (differentiated as nouns, verbs, adjectives, syntagma, etc.) used to name, describe, and qualify each sound were indexed and counted.

Additionally, the events of the workshop and the patients' speech were transcribed after each session by both psychologists in order to compare their perceptions of the observed situations and the verbal expressions. We could then analyze patients' verbal and nonverbal expressions, contextualizing their behavior and speech.

Furthermore, in developing the software tool, we employed a "chirographic" recording method to record the patients' actions on the gesture control MIDI interface. Such recorded data involved the choice of specific sound and music sequences, how long they were played (start/stop), and the changes in playback levels and speed. This automatized digital recording could measure the gestural data generated by the patient's handling of the interface during the workshop sessions, allowing quantitative gestural data analysis. In this way, the patients' actions and certain types of data on their bodily activity were recorded in a noninvasive manner, that is, without a need for body sensors.

Data systematization grids were designed specifically for this experiment to capture verbal and nonverbal (i.e., movements, body positions) data. We defined systematic analytic categories that were extracted from the data collected by the experiment in order to address the

research questions formulated at the beginning of the study. Thus, we could quantify—mainly in terms of percentage, but also with mean, median, mode, variance, and standard deviation—the patients’ verbal and nonverbal data related to the stimuli and mediating objects. In this way, the quantitative analysis complements both the qualitative and quantitative data gathered for this mixed methods research study.

## RESULTS

The young patients showed good adherence to the workshop: Only one patient of the eight decided to stop the experiment after the first session. All other patients attended the entire series of five planned workshop sessions.

### Use of the Mediating Objects

In the presence of the clinical psychologists, each of the patients approached the setting in a highly individual manner, exploring his/her sensations through gestures and movements, and expressing them verbally. Each object lent itself to different types of use, following the patients’ personal preferences and the suggestions made by the psychologists when patients requested it, depending on the conditions of each session. In regard to the data collected, we made two kinds of measurements: the number of occurrences of each object’s use by each patient and total use by all patients together. The overall data of the objects selected and used by the patients during the five workshop sessions show that the ball was the most frequently used object (28% during all workshop sessions, all patients together), followed by the table (21%) and the headrest pillow (20%). As for the remaining objects, the microphone was used relatively rarely (13%). However, the data show that none of the objects was completely ignored (Table 2).

We chose the number of occurrences of use as a unit of measure to mark the patients’ engagement with the mediating objects. The number of occurrences of object use during all workshop sessions indicates one dimension of real use (i.e., how many times all patients turned to and grasped an object). In this sense, it is an indicator of the degree of patients’ activity in relation to the objects. It can express an inner state, a search, or an interest of patients that needs to be analyzed in relation to other indicators in each situation. Indeed, a patient could take an object and drop it quickly. However, returning to it several times, instead of ignoring or abandoning it, indicated a certain engagement by the patient in that specific situation, a search of some sort in

**Table 2.** The Percentage of Mediating Objects Use During All Workshop Sessions for All Patients.

<b>Object</b>	<b>Occurrences of use</b>
Ball	28%
Low, oval table	21%
Headrest pillow	20%
Blanket	18%
Microphone	13%

relation to this object, even if he/she could not always settle in a long or deep exploration. The value of this indicator represents, therefore, only one dimension of behavior that should be interpreted in the light of other data collected in the context of the workshop.

Another indicator of patients' activity with the objects was the duration of use, that is, how much time patients spent in contact with an object. From this standpoint, the total duration of use of each object showed that the patients stayed generally longer with the headrest pillow (34% during all workshop sessions, all patients together), than the blanket (26%), the table (19%), the ball (18%), and the microphone (13%). This measurement also indicates a prolonged body contact with some objects, perhaps with significant subjective engagement, even though those objects were chosen less frequently. Duration of use can express patients' inner state that should be analyzed in relation to other elements gathered in each situation. Therefore, the value of this indicator is not absolute and calls for interpretation within the context. For example, a patient could sometimes take an object and simply forget that he/she is holding it, without exploring or even paying attention to it. The psychologists observed this phenomenon particularly with two patients and in relation to changes in their inner state and the dynamic of the clinical situation during workshop sessions. When they felt depressed or anxious, particularly when talking about their life, they less actively engaged in the exploration of the objects. This happened more often with the headrest pillow and the blanket, which are objects that can be put on the body without needing to be actively held or engaged by the subject. In a future experiment, the frequency and the duration of use should be more thoroughly compared and discussed in the light of qualitative case studies.

What the patients said about their preferences regarding the objects, due to their properties or the sensations they procured, is significantly related to their actual use of them, indicated by the frequency of use (i.e., number of use occurrences), when considering all patients together. However, these data also show a gap between the subjective appreciation of an object (i.e., the value assigned to it by a patient) and the actual use he/she made of it within the situation. Thus, 67% of the patients said they preferred the table because it provided more powerful vibrotactile sensations; 50% said they liked the ball because it induced localized inner sensations, for example, when placed against one's stomach or chest. Likewise, 50% liked the blanket's soft and enveloping texture when lying down on it or wrapping it around their shoulders or waist, even though the object generated fewer vibrotactile sensations. The headrest pillow and microphone represented interest by 33% of patients. The patients were not asked to choose a single preferred object exclusive of others. Moreover, from one session to the next, patients would speak openly about the changes in the way they appreciated the vibrotactile objects. Therefore, the total percentage of object preferences sums up to more than 100% (Table 3).

The difference between the subjective appreciation and the actual use of the object could be due to different reasons. First, as we noted in the Introduction, anorexic adolescents often overinvest in the world of perception and action. Discussions with the IMM clinical team led us to consider that, depending on their inner states, patients with anorexia tend to seek either strong sensations or holding. In this sense, the wooden table and the compact foam ball could appeal to patients looking for sensations because these objects allow a better reception of vibratory sensations. Additionally, as we indicate below, both objects, probably due to their form, allowed a variety of modes of grasping and use, and this could facilitate their psycho-corporeal appropriation by patients. The preference of half of the patients for the blanket could be explained by their need of holding, according to their inner state at a given time. Second, the real use can indicate the patients' search and exploration of the objects. However, it does not

**Table 3.** Percentages for Object Preferences for Specific Audiovibrotactile Mediating Objects as Expressed by All Patients Over All Workshop Sessions.

<b>Object</b>	<b>Occurrences of use</b>
Low, oval table	67%
Ball	50%
Blanket	50%
Headrest pillow	33%
Microphone	33%

directly express their subjective experience of the objects, such as the way the subject represents the qualities of an object according to the sensations, the affect, and the memories aroused by contact.

### **Body Positions Adopted with the Mediating Objects**

Certain objects at times were handled in a highly personal way, particularly the ball and the table. The various postures adopted in relation to these objects pointed toward, on one hand, the framework's high degree of plasticity and adaptability to personal preferences. On the other hand, they also suggested that most patients preferred or decided to stimulate different areas of the body in a range of positions and postures and in relation to the sensations generated by each object. Moreover, the observation of the uses of the mediating objects revealed a wide range of possible configurations, showing each patient's unique preferences, depending on his/her psychic availability and state, which varied from session to session.

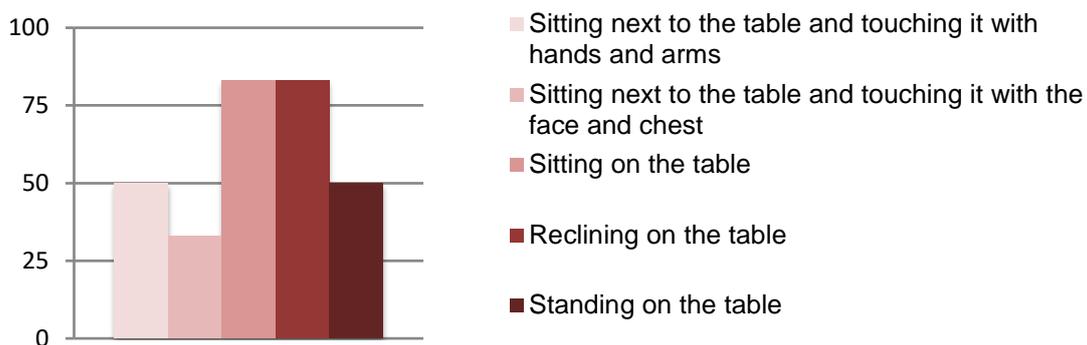
Furthermore, patients typically explored spontaneously each mediating object individually. However, they engaged at times two or more objects simultaneously during the sessions on their own initiative and based on their own preferences—as well as with the suggestions from the psychologists, according to the situations at hand. The most frequent combinations of the mediating objects were the pillow and the ball and the pillow and the blanket (both 30% of use occurrences, all patients together). The next most common combination was the simultaneous use of the ball, the pillow, and the blanket (i.e., the same three objects used together). On two occasions, all four mediating objects were used simultaneously by one female patient.

The ball and the table encouraged the most diverse and surprising positions, postures, and physical handling the objects, with six and five categories of use, respectively. (These categories are presented in the figures associated with the subsections below.) They were followed in the classification by the headrest pillow, the blanket, and the microphone, with four different categories of use, detailed below. The pillow and the microphone were associated with more exclusive uses in regard to the possibilities explored by the patients; the table, the pillow, and the blanket led to more equally distributed types of use.

#### **The Table**

All patients explored the table without showing any apprehension, either of their own initiative or with the psychologists' suggestion. They had no difficulty coming near it or even lying down on it, except for one female patient who chose to sit rather than lie down. Some patients explored

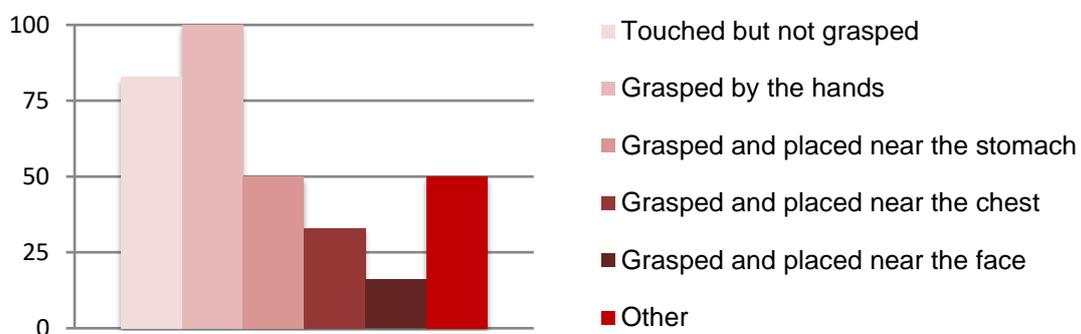
the table spontaneously and frequently, in a highly personal way from one session to the next— by touching it with their hands and arms; with their forehead, cheek, or chest; by sitting in front of it; by sitting, lying down, or standing on it. The most frequent uses of the table were in the reclining position, on one’s back or side in a fetal position (83% of patients, 30% of use occurrences) and in a sitting position (83% of patients, 28% of use occurrences). Half of the patients (50%) would sit next to the table to touch and explore it, as well as climb upon it. One particular female patient chose this last position regularly during her five workshop sessions, staying on the table in standing position, sometimes touching it with the sole of her foot, sometimes only with her toes as in classic dance movements (Figure 5).



**Figure 5.** Percentage of uses of the low, oval table by all the patients over all workshop sessions.

### The Ball

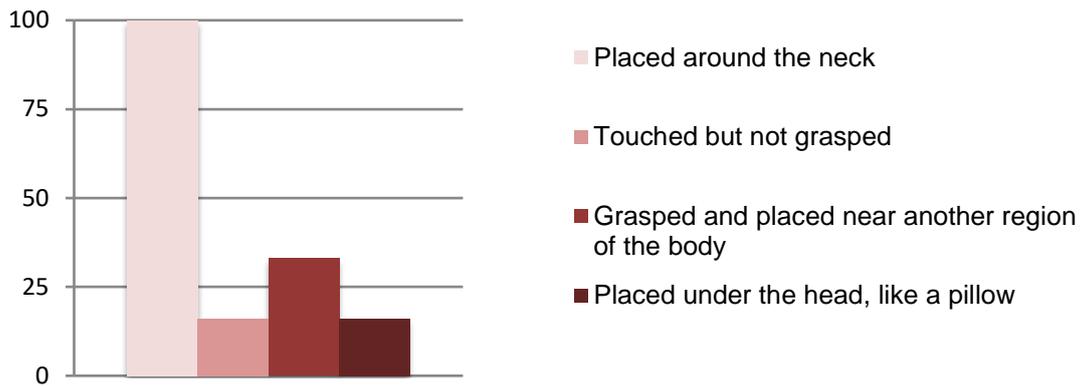
The ball was most often grasped by the hands (100% of patients, 47% of use occurrences, for all patients). To a lesser extent, the ball was touched without being grasped (83% of patients, 15% of use occurrences), or grasped and placed close to the stomach (50% of patients, 15% of use occurrences) or the chest (33% of patients, 9% of occurrences). When not grasped with hands, patients put one or both hands atop the ball, which was located on the carpet. Even though this interaction with the ball was less frequent, these uses were significant insofar as they presented repeatedly and were common to several patients. Some patients explored also other uses that did not involve grasping with the hands. Other areas of the body and positions were explored, such as placing the ball under the toes, on top or under the head, using this spherical and soft object to feel the vibrations in other places of the body (Figure 6).



**Figure 6.** Percentage of uses of the ball by all the patients over all workshop sessions.

### The Headrest Pillow

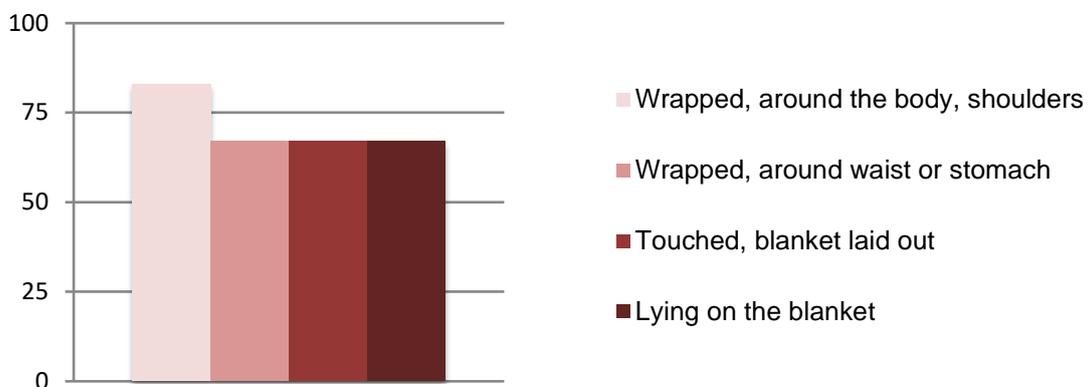
The patients placed the headrest pillow mainly around their necks while sitting or lying down (100% of patients, 83% of use occurrences). However, to a lesser degree, other unique uses were explored: grasping and placing the pillow near other parts of the body, such as the legs, thighs, or the palm of the hand (33% of patients, 10% of occurrences; Figure 7).



**Figure 7.** Percentage of uses of the headrest pillow by all the patients over all workshop sessions.

### The Blanket

The use of the blanket fell into four categories, equally distributed among the patients. It was used by patients mainly as an enveloping object, wrapped around their shoulders or waist, when sitting or lying down (83% and 67% of patients, 40% and 18% of occurrences of use, respectively). Significantly, it was used for other explorations as well, especially as a contact surface spread out on the floor, for manual exploration or to lie on (67% of patients, 21% of use occurrences). This object therefore invited other types of exploration beyond those for which the framework was originally designed (stimulation of the neck, shoulders, or shoulder blades), which suggests that its vibrotactile mode encouraged playful exploration due to its softness, flexibility, and ability to cover large areas of the body (Figure 8).

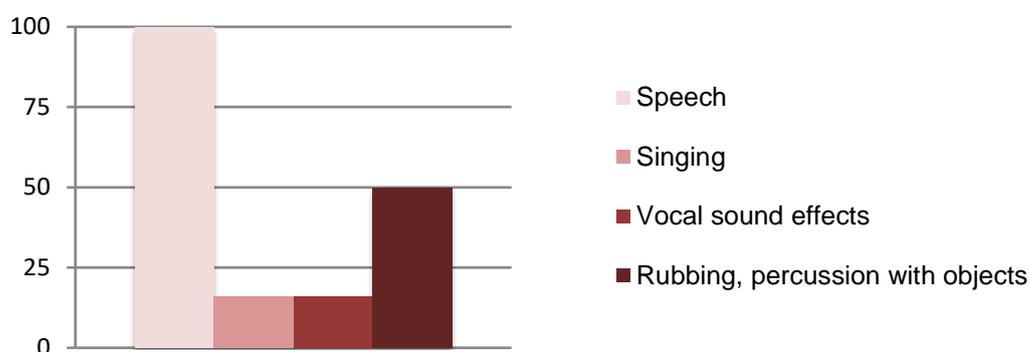


**Figure 8.** Percentage of uses of the blanket by all the patients over all workshop sessions.

## The Microphone

Although it was used relatively less frequently than the other objects, the microphone was explored in one way or another by all patients (100% of patients, 54% of occurrences), especially to speak to the interacting psychologist (only one of the psychologists used the microphone for a regular exchange). In this sense, the sessions showed that the microphone helped create a verbal exchange between the patient and the psychologist. The microphone is not the same type of mediating object as the table, blanket, pillow, or ball, which all transmitted sound via their vibrating properties. Rather, it functioned similarly to the MIDI interface: It transmitted an acoustic signal to the mediating objects, but does not itself vibrate. However, it differed from the MIDI interface's role of transmitting recorded sounds in that it captured the acoustic signal produced by the patient in real time and transmitted it to the vibrating mediating objects. The microphone thus served as an unprogrammed sound source, enabling patients to express themselves spontaneously by using their voice, but also by rubbing the microphone or producing nonvocal sounds—and receive sensory feedback.

Certain patients expressed, at a particular moment, an uncanny feeling on hearing their own voice or feeling its vibrations (e.g., “*It’s bizarre;*” “*strange;*” “*like a story within a story*”).<sup>9</sup> Yet half of them (50%) also used the microphone to generate percussion sounds, to accompany impulse-like sounds such as the heartbeat (BBC, n.d.c) or to produce the sound of a galloping horse in imaginary sound scenes. A female patient repeatedly explored vocal sound effects such as breathing, sighing, and tongue-clicking to create scenes with other sounds, for example, the sound of stone skipping (Figure 9).



**Figure 9.** Percentage of uses of the microphone by all the patients over all workshop sessions.

## The Choice of Sound and Music Sequences

All the sounds were explored by the patients more or less repeatedly according to their personal preferences. On the one hand, the sounds were mostly chosen by the patients. However, in some circumstances—on the patient's request, depending on his/her mental state or a difficult associative moment—certain sounds were suggested to patients by the psychologists in order to (re)start the process of association. On the other hand, the patients listened to the sounds generally through body contact with the audiovibrotactile mediating objects, and, thus, they simultaneously felt sound vibrations. They sometimes verbally expressed their feelings about music and vibrotactile mediation: “*I like the vibrations. I prefer them to sounds*”; “*I like the sensations—with music, I’m more used to it ... but the sound also helps because it gives you ideas at the beginning*”; “*It was*

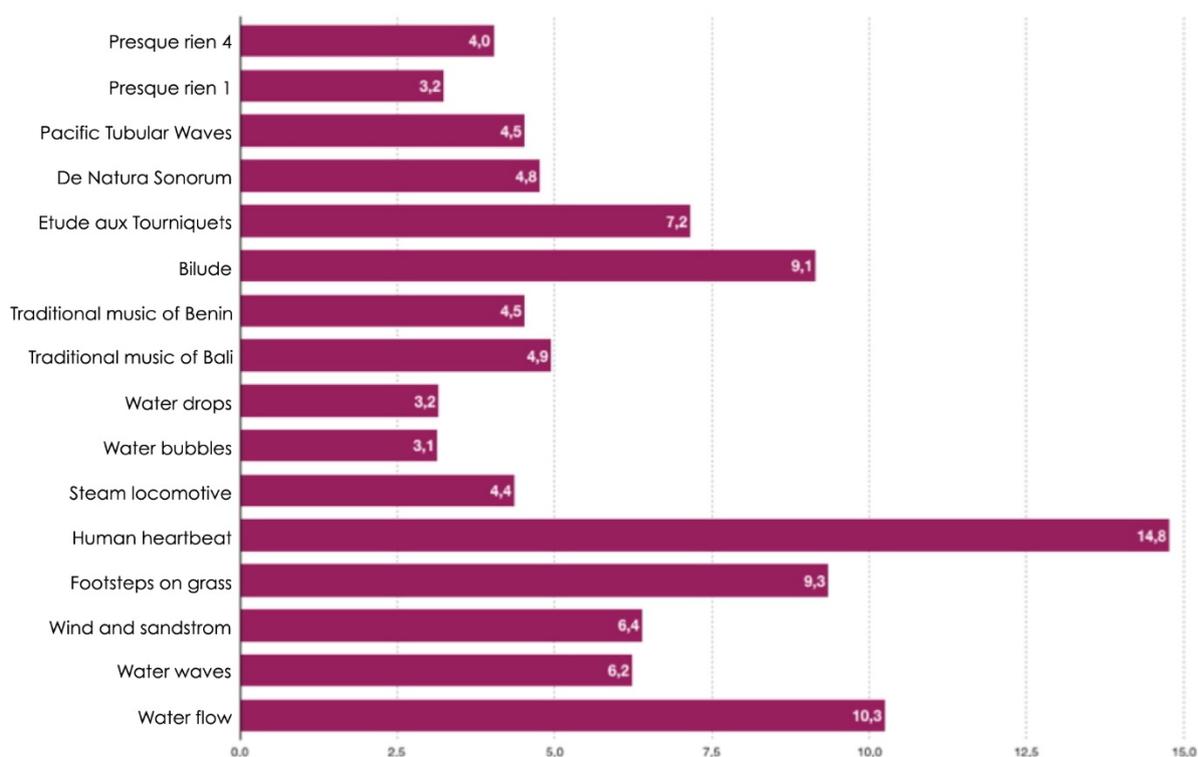
*nice, the sounds brought different scenes into my mind—I like the vibrations; “I find it more pleasant when the vibrations are stronger.”* Nevertheless, the patients sometimes explored sounds or music without necessarily using an audiovibrotactile mediating object. They would perceive them in a purely auditive way (through the aerial acoustic radiation produced by the vibrating mediating objects). The framework thus enabled a type of back-and-forth movement between tactile sensations and auditory perceptions.

The sounds that patients most often identified as their favorites were the sound of waves related to the sea (BBC, 1981; 83% of patients), heartbeats (BBC, n.d.c; 83%), and the musical excerpt “Bilude” (Schaeffer, 1979/2010c, CD 3, track 17; 33%), according to the responses the patients gave to one of the questions posed at the end of each session. Other sounds were considered pleasing and calming because of the scenes or sensations they evoked, such as the sounds of flowing water (BBC, n.d.d), of footsteps on grass (BBC, n.d.b), or the two excerpts from the soundscape music piece “Presque Rien N°1” (Ferrari, 1970/2009a, CD 3, track 1, 1990-1998/2009b, CD 3, track 9). Certain sounds, such as the train (Schaeffer, 1948/2010a, CD 1, track 1), the bubbling water (Genevois, 2019), or isolated water drops (Genevois, 2019), were deemed pleasant by some patients but unpleasant by others. However, feelings about particular sounds could change during the course of a single session or from one session to another, depending on the patient’s mental state, the moment in the verbal discussion with the psychologists, or the process of modulating and combining the selected sounds. Based on what the patients expressed verbally during the sessions, sound sequences such as “Étude aux Tourniquets” (Schaeffer, 1948/2010b, CD 1, track 2), “De Natura Sonorum” (Parmegiani, 1974/2008, CD 5, track 9) and “Étude aux chemins de fer” (sound of trains; Schaeffer, 1948/2010a) were perceived as unpleasant and even anxiety producing by some patients because of the psychic associations and bodily sensations they induced: *“It makes me think of home, with strange beings, strange beings who ring bells”* and *“I’m afraid of the train because on the train you often have to eat. I can’t wait to satisfy my hunger, so I eat everything very quickly, and suddenly it’s complicated.”*

Moreover, the same sound could refer to a variety of ideas and emotions (of pleasure or displeasure), depending on the playback speed and sound level. These two sound parameters could lead the patients to contrasting affective and emotional situations and positions, revealing an affective ambivalence. Depending especially on the playback speed, sounds perceived as pleasant and calming could become unpleasant and frightening: an accelerated heartbeat (BBC, n.d.c), slowed-down dripping water (Genevois, 2019), the “Bilude” (Schaeffer, 1979/2010c, CD 3, track 17) piece played more slowly or more quickly. For example, several patients liked the “Bilude” excerpt because it alternated between light piano melodies and the sounds of everyday life. However, when played more slowly, the same excerpt led to the following associations in one female patient: *“It’s a little more morbid”, “It sounds a bit sinister”, “...a haunted castle, a great mansion or a cemetery, there are monsters and ...it’s scary and ... it’s as if there was a huge skeleton playing the piano”, “It’s all white and ... it’s scary I think and... it’s enormous.”* The sound of heartbeat could be felt as pleasurable at a normal or slow speed (e.g., *“I like the heartbeat”*; *“You need to hear it, don’t you?”*) and disagreeable or anxiety-provoking at a higher speed (*“It’s stressing me out—I don’t like it so fast”*). Therefore, the very identity of the sound, not only the ideas and emotions the patient associated it with, would sometimes change depending on the sound levels and playback speed variations. For example, when slowed down, the sound of the train in “Étude aux chemins de fer” (Schaeffer, 1948/2010a, CD 1, track 1) led some patients

to the impression of entering an underwater world (e.g., “It’s like going into the water”; “... a bit like we were underwater—it’s a little blurred”) or being at the heart of a storm (e.g., “It looks like a thunderstorm—I have a little storm”; “I imagine a wind and it moves an antenna—a lighthouse antenna by the sea”).

The analysis of the verbal associations and the vibrasonorous play (gestural control of the MIDI interface by the patients) suggested that the manifest preferences for certain sounds often corresponded with the recall of these sounds during the session. So, the analysis of the total accumulated duration of each of the sounds triggered, when considering all patients and all sessions together, shows that the sound of heartbeat (BBC, n.d.c; 14.8%), flowing water (BBC, n.d.d; 10.3%), footsteps on grass (BBC, n.d.b; 9.3%), and the excerpt from “Bilude” (Schaeffer, 1979/2010c, CD 3, track 17; 9.1%) were activated for the longest period of time. Sounds of bubbling water (Genevois, 2019; 3.2%) and isolated water drops (Genevois, 2019; 3.1%) were explored to a lesser extent. However, patients also spent significant time listening to the extracts from “De Natura Sonorum” (Parmegiani, 1974/2008, CD 5, track 9; 7.2%), “Étude aux Tourniquets” (Schaeffer, 1948/2010b, CD 1, track 2; 4.8%), and “Étude aux chemins de fer” (Schaeffer, 1948/2010a, CD 1, track 1; 4.4%), which were nevertheless perceived as unpleasant or stressful by certain participants. These sounds were not explored to a lesser degree than others, such as the traditional music from Benin or Bali (Rouget, 1990; Sentana, 1991, track 4) or the excerpt from “Presque Rien N°4” (Ferrari, 1990–1998/2009b, CD 3, track 9; Figure 10). Therefore, sounds that had not been explicitly perceived as preferable or pleasant by patients were still used nevertheless and also generated associations, as expressed by the patients.



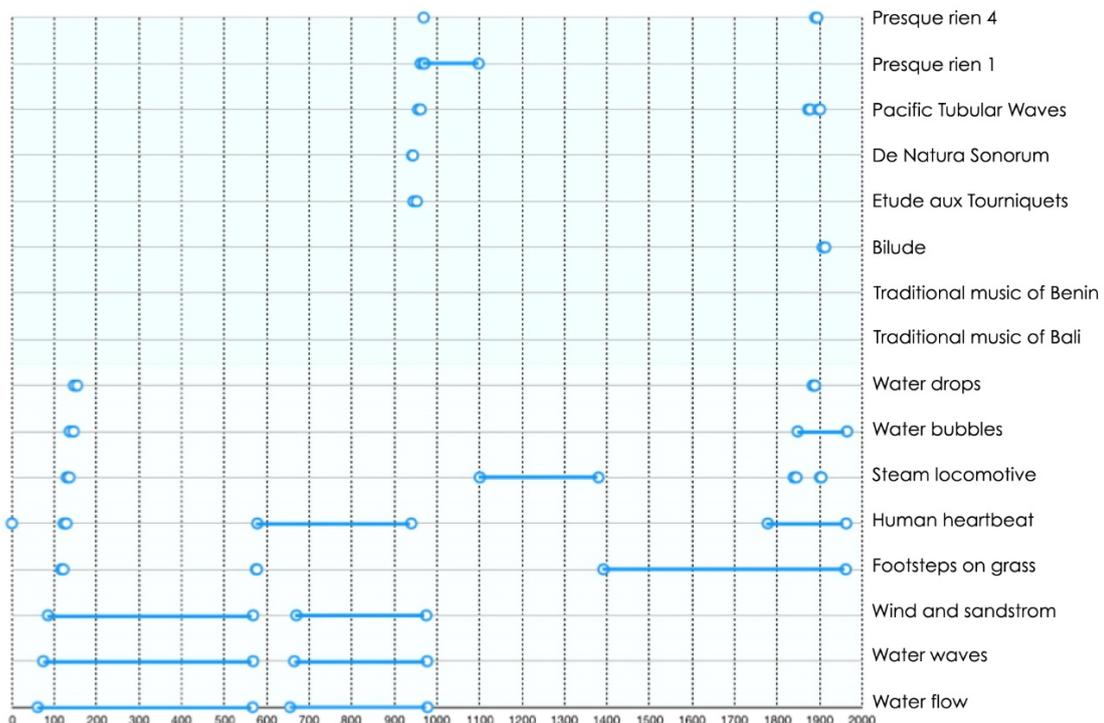
**Figure 10.** Histogram of time spent on each sound, all patients combined during all workshops. The x-axis expresses the percentage of activation time of each sound in relation to the cumulative duration of all sounds.

The relative differences between the verbally expressed “preference” for certain sounds and the actual use of these sounds in the sessions by patients and psychologists required us to consider the associative relevance of the different sounds, that is, their ability to mobilize and highlight deep affect and representations, which involve the psychic conflicts to be elaborated through therapeutic work. Just because a patient perceived and identified a sound as unpleasant or strange does not mean that it cannot generate associations indicative of psychic contents or help elaborate them.

Although each sound was explored separately, at times they also were activated together by the patients—and sometimes by the psychologists when patients asked them to do so. Consequently, it was frequently a combination of sounds and music that led to verbal associations with various sensations, ideas, and emotions. In particular, the sounds evoking water and the sea (i.e., the sound of flowing water in a natural environment [BBC, n.d.d], the water waves [BBC, 1981], or the wind and the sandstorm [BBC, n.d.a]) were activated and grouped together by the patients as sounds linked to “the sea” (Figure 11).

### Verbal Expressions Linked to Sound and Music Sequences

Patients used sounds to nonverbally express their singular mental images and affect. Sometimes, they verbally expressed these representations and affect associated with sounds. We analyzed the semantic content of their verbal utterances directly referring to the sounds. The percentages below represent the number of occurrences of the semantic units relative to the total number of these units counted for all of the sounds.



**Figure 11.** Temporal representation of the sounds triggered by a patient during one session. The x-axis expresses time, marked here by a vertical line every 100 seconds (temporal representation scale of the duration of the session).

The sounds that provoked the most verbal associations directly linked to their sensory, sonorous, and vibrotactile properties were the sounds of the waves related to the sea (BBC, 1981; 12% of occurrences); the sounds of flowing water (BBC, n.d.d; 10.6%); the second excerpt from Ferrari’s “Presque Rien N°4” (1990–1998/2009b, CD 3, track 9), which was associated with the countryside (10.6%); the sounds of footsteps on grass (BBC, n.d.b; 9.3%); the extract from “Bilude” (Schaeffer, 1979/2010c, CD 3, track 17), including piano music and sampled everyday sounds (8.8%); the wind and sandstorm (BBC, n.d.a; 8.4%); and the sounds of heartbeat (BBC, n.d.c; 7.5%). These results are presented in Table 4. The discourse analysis of the verbal associations suggests that the available sounds and music lent themselves to a wide range of unique associative chains, specific to each patient, beyond the few common themes that we could identify: groups of unfamiliar beings (e.g., “*the tribe*”; “*strange beings*”; “*nonhumans*”; or “*extra-terrestrials*”), bathing, swimming on the surface of or under the water, horses and galloping, the storm and the tempest, and travel and movement. The motifs of water—as the sea, rain, storm, or tempest, and including situations such as swimming on the surface or under water, or even drowning—appeared very frequently (36% of occurrences). Sounds linked to

**Table 4.** Percentage of Verbal Associations Produced by All Anorexic Patients to the Stimuli During All Workshop Sessions.

<b>Sound/music stimuli</b>	<b>Verbal occurrences (%)</b>
Water waves (BBC, 1981)	12.0
Water flow (BBC, n.d.d)	10.6
“Presque Rien N°4” (Ferrari, 1990–1998/2009b, CD 3, track 9)	10.6
Footsteps on grass (BBC, n.d.b)	9.3
“Bilude” (Schaeffer, 1979/2010c, CD 3, track 17)	8.8
Wind and sandstorm (BBC, n.d.a)	8.4
Human heartbeat (BBC, n.d.c)	7.5
“Presque Rien N°1” (Ferrari, 1970/2009a, CD 3, track 1)	5.7
“De Natura Sonorum” (Parmegiani, 1974/2008, CD 5, track 9)	4.8
Steam locomotive (Schaeffer, 1948/2010a, CD 1, track 1)	4.4
Water drops (Genevois, 2019)	3.5
Music of Benin (Rouget, 1990)	3.5
Bubbling water (Genevois, 2019)	3.1
“Étude aux Tourniquets” (Schaeffer, 1948/2010b, CD 1, track 2)	3.1
Music of Bali (Sentana, 1991, track 4)	2.2
“Pacific Tubular Waves” (Redolfi, 1979/1988, track 6)	1.7

the images of the sea also brought up associations with family holidays. The sounds of water waves related to the sea (BBC, 1981; 18.5%), flowing water (BBC, n.d.d; 17%), footsteps on grass (BBC, n.d.b; 14%), and the wind (BBC, n.d.a; 10.5%), therefore, induced associations with the names of places linked to individual memories. For example, the sound of waves related to the sea evoked precise geographical locations such as Nice, Playa del Carmen in Mexico, and Morbihan in Brittany, Biarritz, or Dunkirk, referring to the patients' life experiences. Other sounds also fulfilled this function, though to a lesser extent.

After having spontaneously identified the sounds via their referents (the sea, the storm, dry leaves, a train, etc.)—at times using objectifying language in the third person (“*It’s a...*”; “*It could be called...*”) and at other times more subjectivizing language in the first person (“*It makes me think of...*”)—most patients would let themselves engage, with more or less difficulty, in more personal free association, often encouraged by the psychologists. In other words, for a given patient, a particular sound could refer to a general object or phenomenon in the outside world, as well as to a unique situation. For example, for one female patient, the “Bilude” piece (Schaeffer, 1979/2010c, CD 3, track 17), the sound of footsteps on grass (BBC, n.d.b), and the wind and sandstorm sound (BBC, n.d.a) led to the following association: “*A boy is trying to escape—he’s running away from his parents.*” And even though all of the patients identified the railway sounds (Schaeffer, 1948/2010a, CD 1, track 1) as a train, for one patient, this was specifically the train “*to go to the university.*” The sounds of flowing water (BBC, n.d.d), water waves (BBC, 1981), and the wind (BBC, n.d.a) universally evoked imagery of the sea but, for one patient, these and other sounds generally reminded her of tempests and storms, repeatedly featuring the theme of drowning: “*We are at the seaside and there is some music and a storm is coming,*” “*It’s going to break the piano,*” “*It’s broken,*” and “*I’m drowning.*”

The direct reference to the sounds did not exclude another level of verbal associations linked to the patient’s life experience and memories that were not based on or directly refer to these sounds. This level of associations linked to patients’ life experiences was very present. The sounds and their vibrations could therefore embody and support the elements of the patients’ experiences, facilitating mental representation and expression. As a result, sounds could function as a kind of background projective material (e.g., elements of the soundscapes and imaginary scenes), helping patients express their experiences—*affect and representations*—without having to explicitly refer to the perceived sound (i.e., the description and qualification of the stimulus).

## DISCUSSION

The pilot study investigated how patients suffering from an anorexia nervosa explored sound-initiated vibrotactile mediating objects within a space delimited by a carpet, in a process of associative expression. The experiment raised questions that should be investigated further in the future. Some of these questions relate to the clinical function of the mediation framework with respect to the patients’ responses to it. We can address several topics for a general analysis in regard to the results.

In terms of the physical and mental appropriation of the mediating objects, the bodily positions and the use of the various audiovibrotactile objects highlighted the particular psychic positions of each patient, depending on the specific aspects of his/her history. For instance, we could see that the data gathered in study could support the probability of the patients seeking to contain and relieve

threatening emotions; expressing a need for control exercised through demanding bodily postures; demonstrating intense bodily activity expressing fantasy scenarios; and/or searching for a reassuring object in order to feel one's body exist. These clinical categories were qualitatively drawn from the intersection of various kinds of information: how patients used the sounds and the objects during the sessions; what patients said in each workshop session about themselves, their situation, and emotions; and general information about patients' medical treatment communicated by the clinical team at the beginning and the end of the experiment. Thus, some patients spoke about their feelings related to their past and present lives, expressing anxiety, anger, or sadness. These patients sought contact with the mediating objects through quiet body postures, such as lying down, placing the ball near their stomach or chest, or wrapping themselves in the blanket. They often expressed a search for relaxation: "*The session today helped me relax*"; "*It feels like a warm container and at the same time covering, it helps me relax.*" Patients also sought to control their emotions through demanding bodily postures, such as standing on the table upright on the toes for long minutes, or by looking for strong sensations (e.g., "*With the feet, it spread all over the body while with the hands it spread differently—it's because I practice dancing*", "*It reminds me of memories, with cousins—it was nice—my heart was beating very fast, I was stressed*"; "*A little bit like heartbeats, it makes you feel something, we live a little like that*", "*I was a bit into the sensations and the vibrations, because in the end I tried to put all the music together*"). Moreover, a female patient used the objects to bodily enact her own stories and fantasy scenarios (e.g., "*There we will have to clean up. We are going to try to make a house ... here we are, now we are going to build a huge bed, a bed with 30 places ... we must build the table*"). In these various situations, patients used objects to reassure themselves. This analysis on the clinical functions of the uses of the platform for therapy should be developed more fully in a future experiment.

Contrary to our initial hypotheses, the patients did not express verbally or nonverbally (i.e., via speech, smile, eye contact, body posture, initiating use, or by frequency/duration of use) any significant difficulties or concerns in entering into contact with mediating objects. In the case of the low, oval table, most seemed pleased to explore it by using a wide variety of bodily positions, that is, patients could lie or sit on the table as on a large bench. Perhaps this is because, outside its usual social context, the low, oval table has a deliberately ambiguous shape and thus evokes functions other than that of the symbolic object associated with food. Thus, the table provided an opportunity and possibly encouragement for patients to invest in their psycho-corporeal relationship with the object in other ways. Because of its physical properties, the table also transmitted the most powerful vibrotactile sensations. On the opposite end of the usage scale, the blanket was less effective in this sense, although patients did like its soft and enveloping texture, which fulfilled a containing function. A future study will require improving the technical implementation of this device.

The patients did not avoid any of the sound sequences. However, the sounds and vibrations associated with the sea and the heartbeat were particularly meaningful for a number of patients (e.g., "*It's like I can really feel my heart beating.*"). These particular sounds encouraged the emergence of sensations, affect, and memories, some perhaps buried deep within the body. However, this outcome was not due to the sound phenomenon per se, but rather to the potential of transmitting sound through vibrations in the clinical framework as a whole, which facilitated the process of association.

The use of the gesture control MIDI interface was clinically significant in the workshop. Allowing patients full control in turning on and off and modulating sound excerpts was intended to prevent the adolescents being passively exposed to stimuli, given the dependency and control issues associated with anorexia nervosa. As noted in the Introduction, anorexia sufferers' need for control to cope with internal strains, albeit at his/her own expense, is a symptom of the disorder. Thus, our clinical approach to give these young patients the possibility to control some parameters of sound and vibration—and to manipulate the mediating objects themselves in order to modulate their sensations—made good sense. We believe the patients' appropriation of the mediation platform was a condition for them to appropriate elements of their unique personal experiences. In this sense, the use of the gesture control MIDI interface by the patients offered a condition to work with them on more flexible modes of control, where the issue is appropriation and modulation of sensations and emotions. The psychologists observed that patients more often used the binary control option of the MIDI interface to turn sound sequences on and off. They were generally less inclined to spontaneously use the modulation function of the interface. However, when invited to explore this function, some of them used it to explore their feelings, talk about their experiences, or imagine associative scenes. Nevertheless, the clinical function of the gesture control interface should be more systematically assessed in a future experiment.

Although the framework was particularly effective with some patients, others found it difficult to express their associations. Two female patients in particular brought forth relatively few associative elements. They opted for descriptive and operative statements about the sounds, objects, and vibrotactile sensations, using objective language; alternatively, they would simply say whether they found the sensations pleasurable or not (e.g., "*I don't like it*", "*It's not satisfying*"). As a result, the psychologists sometimes were confronted with the patients' difficulties in entering into the audiovibrotactile play due to inhibition, resistance, or by attacking the therapeutic alliance (e.g., "*I don't know what to do anymore*"). In these situations and respecting the process of each patient, the psychologists used techniques of punctuation, reformulation, and relaunch by making open suggestions.<sup>10</sup> In other words, they had to find a way of intervening in the setting to overcome these problems, to restart the process of play, and encourage association. This observation suggests that the sound, music, and vibration mediation framework requires a clinical setting that should include psychologists as mediators between the patient and the objects. The clinical setting of this experiment, especially with vulnerable patients, thus demands the presence of trained professionals.

Moreover, despite its facilitating function, the mediating framework cannot entirely replace therapy. It is inspired by therapeutic methods, such as the Squiggle Game (Winnicott, 1971b) and the reconstruction of body image through clay modeling (Pankow, 1977). However, the framework was not conceived as a form of therapy in itself; rather, the framework serves explicitly as a facilitator of therapeutic work conducted in a separate and specific setting. It therefore should be used in conjunction with the work of an institutional team.

The results of this pilot experiment were presented and discussed with the IMM clinical team. The feedback was positive, but the short duration of the exploratory study does not allow us to account for its possible medium- and long-term therapeutic effects. The study aimed to assess patients' appropriation of the mediation platform and their responses to it. We assessed the evolution of patients' state from the beginning to the end of the workshop on the basis of their behavior and speech during the workshop sessions. We compared the observations of the psychologists with information communicated by the clinical team on the patients' medical

treatment. No patient psychologically decompensated during the experiment. Some of them were able to talk about their symptoms, family situations, and emotions during the workshop sessions.

The evidence from this pilot study seems promising; nevertheless, the study raises questions about the potential impact of this workshop on the usual follow-up treatment of patients by the hospital team. We also need clarity on the issue of how long this therapeutic mediation framework should be employed: Could it be used for more than five sessions with each patient? And if so, would it interfere with other modes of treatment within the institution? A new study could help in understanding whether long-term use might be beneficial, might exhaust the framework's possibilities, or become an object of resistance to the ongoing therapeutic work. Our assumption is that the therapeutic efficacy of this platform is linked to its ad hoc, occasional application: It was designed as a short-term workshop (five sessions) and all but one of the patients agreed to this duration. Its precise beneficial length is to be determined through further research. Moreover, in longer term experimentation in the future, we intend to formalize a questionnaire to assess more thoroughly how this platform influences the inner experience of the patients with respect to their clinical situation.

## **CONCLUSIONS**

The specificity of this platform lies in its ability to offer pliable objects that function as springboards for the inner experience of sensations, emotions, and ideas. The sound stimuli and the mediating objects of this framework have demonstrated a high degree of plasticity, lending themselves to various uses and singular associations. The sounds and their vibrating properties were appropriate as projective materials, which could adopt a different sound identity for each patient, or even for the same patient within the space of a session or from one session to another. This was enabled by the questions, follow-ups, and play suggestions made by the clinical psychologists.

For the patients, the platform fulfilled certain essential clinical functions: relaxing or calming bodily sensations; investing in certain zones of the body by seeking powerful feelings; expressing emotions and associative processes by either creating stories (fantasy scenarios), or recalling memories and talking about current experiences. The analysis of the verbal data centered on the patients' relationship to their sensory experience has shown that the setting encouraged the expression of these associative movements in speech, while providing the patients with a containing framework. In this sense, the mediation platform satisfies the objective of this study.

Its scientific value and originality also lie in its ability to bring together several disciplinary approaches, whose respective abilities and expertise were necessary to implement this research. Specifically, this clinical therapeutic work could not have been carried out without the involvement of musicologists and musical acoustics engineers.

## **IMPLICATIONS FOR THEORY AND APPLICATION**

The framework has demonstrated its potential when working therapeutically with young anorexic patients, whose mental life is organized defensively by exerting strict control over emotions and sensations. This mediation platform gives an important place for body exploration as a means of self-exploration, that is, working with these patients on the contents

of their psychic lives from their immediate bodily experiences. Thus, from a research perspective, this study contributes important findings regarding the role of vibrotactile and audiovibrotactile interventions and, especially, the benefit of specific mediating objects, results that can benefit from future studies. The design of this type of mediation platform—intended to not to expose these patients to stimulation in a passive and solitary position—supports future investigation into how to provide patients the possibility to be active in regard to the mediating objects and to allow them to make a transition between control, modulation, and release regarding their inner experiences. Moreover, the actual experimentation with patients and the results indicate that the support of trained psychologists is essential for the clinical implementation of this type of mediation platform. It is important for patients to give a place to the meaning of bodily experience through the associative process expressed verbally. Thus, if adapted to any given clinical context, this experiment could help guide the design of similar mediation platforms for working with adolescents driven to extreme modes of defense or with major risks of violent or self-destructive behavior.

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## ENDNOTES

1. DSM-5 is the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders*, published by the American Psychiatric Association in 2013.
2. Max is a visual programming language for the specialized needs of artists, educators, and researchers working with audio, visual media, and physical computing. Max is developed and distributed by Cycling '74, an American software development company, and is infinitely flexible for creating interactive media software. See <https://cycling74.com/products/max-features> for more information.
3. The experiment *Histoires sensibles* (2012–2013) and the empirical study with the vibrotactile bracelet (2015) were part of the PANAM project funded by the French National Research Agency.
4. In the “packing” method, a patient’s body is wrapped in wet fabric within a psychotherapeutic context. This method is used at the IMM to reconstitute the psycho–corporeal envelop of the patient and is built upon the human relationship between the patient and the hospital practitioner.
5. More of the stimuli were wide-frequency range sources (from 30 Hz to 20 kHz), as were some music selections and soundscapes. A filtering was added due to the specifications of each transducer (i.e., some with full-range frequency response) and the coupling effects of each vibrotactile object (depending on its size, materials, and the level of stimuli). In actual use, the measurement of cut-off frequencies is critical, as this also depends on the area of the body being stimulated.
6. Both the water drops and bubbling water sounds were created by H. Genevois for an immersive installation commissioned by the Centre National de Création Musicale (GMEA) for “The Week of Sound” in 2019, in Albi, France. These sounds are not copyrighted. Genevois created them from two programs he wrote in Max. Both sound excerpts are derived from random generative algorithms. The idea behind these creations was not to make “real sounds” but rather to create imaginary drops and bubbles to question human perception.
7. MIDI (short for Musical Instrument Digital Interface) is a technical standard that describes a communications protocol, digital interface, and electrical connectors that connect a wide variety of electronic musical instruments, computers, and related audio devices for playing, editing, and recording music.
8. The expression “plastic object” refers to an object’s capability for being molded or receiving form—materials such as, for instance, clay, wax, and polymers—especially during a creative process related to art. This type of object can be also referred to as a pliable object because it is flexible and easily adaptable. The German and French psychoanalyst Gisela Pankow (1977) employed this notion to

explain the use of modeling clay in her therapeutic work with patients. Thus, in therapy, a plastic object refers to various mediating external supports that help patients to transform their inner experiences (Brun, 2019).

9. The qualitative data such as the patients' speech were gathered in French. Data quotes were translated into English for publication by a translator who discussed specific wording with the authors of this paper. Additionally, for clarity in this text, commas are used to separate multiple comments from a single patient; a semicolon separates quotes from multiple patients.
10. Punctuation, reformulation, and relaunch are verbal techniques used by the clinician in psychoanalytic therapy and clinical interview to help the patient engage in the expression of an associative process, as well as to recognize some contents within his/her own speech. Punctuation is a way of intervening at certain time to introduce pauses and articulations in the rhythm of the speech; reformulation is when a clinician presents what the patient has said in alternative wording; and a relaunch is to renew the associative process by asking a question, making a comment, or providing a suggestion.

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