Chapter 17
Interactive Multisensory VibroAcoustic Therapeutic Intervention (iMVATi)

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Abstract This chapter introduces two case studies that exemplify how interactive visualisations were introduced to supplement an interactive vibroacoustic therapeutic intervention setup for adolescents diagnosed as profoundly disabled each having individual dysfunctional conditions. The hypothesis behind the research of multisensory stimuli intervention aligns with how humans can differ in needs, desires, and preferences and it is posited toward optimising selectable feedback stimuli within intervention targeting inclusive well-being. The studies were associated to a European funded research project (https://www.bristol.ac.uk/carehere) (with end-users overall being handicapped and/or elderly and/or undertaking rehabilitation) where the author coordinated Sweden partner research and user studies due to his research being catalyst and responsible for gaining the project. Both case studies took place in a school for special needs in Landskrona municipality, Sweden—they were conducted applied as a part of the day-to-day activities of the school rather than being laboratory-based.

Keywords Vibroacoustic therapy · Multimodal stimuli · Modes of therapeutic interaction · Virtual interactive space (VIS) · Profound and multiple learning disabled (PMLD)

17.1 Introduction

This chapter contributes with overviewing two case studies illustrating various technologies for inclusive well-being where a focus was on establishing a ‘treatment’ intervention environment concept that was modular and flexible to offer adaptable and tailored multisensory stimuli feedback responding to participant input. Participants are both teenagers diagnosed as profound and multiple learning disabled (PMLD).
Interactive feedback stimuli are selectable multimedia that responds to a person’s input (feedforward) movement sensed within what is coined as Virtual Interactive Space (VIS—Brooks 1999). These stimuli typically include interactive auditory and/or visual environments, for example (Serious) Games, Virtual Reality, Music making (typically improvisation as real-time composition), Digital Painting (abstract), Visual manipulation of geometric patterns, and more. In these case studies a vibroacoustic setup has been incorporated toward realising vibroacoustic therapeutic intervention as an interactive form (i.e. where the participants generate their own audio-visual plus vibratory stimulus, within VIS environments. Related literature cited includes a body of work titled ‘Sound Therapy’, elaborated by Swingler [59] and Ellis (1995–2004) wherein the approach to intervention aligns with this authors experiences, beliefs and positioned argument.

The setup incorporated interactive multisensory vibroacoustic therapeutic intervention according to the staff decisions from knowledge of each participant and with comprehension of their likely response to the additional stimulus of visuals. This meaning that a participant’s feedback incorporated auditory and visual stimuli that was synchronous with vibratory haptic/tactile stimulus, all empowered for self-triggering/self-manipulation/self-control toward promoting a sense of achievement, self-agency, and efficacy.

This research was catalyst to national and international (European) funded projects within rehabilitation with end-user participants across ranges of age and diagnosis including handicapped, elderly, and/or undertaking rehabilitation, and situation 1.

17.2 Biofeedback

A point of departure for this chapter is biofeedback.

Historically positioned within the holistic body of work that led to the European project mentioned in the opening of this chapter includes research of biofeedback systems. These are systems that typically use electrodes positioned on parts of a human body to generate signals indicating bodily function and change. As well as informing via data on bodily function that correspondingly offer indications of the participant’s experience and related emotion (e.g. heartbeat, brainwaves, galvanic skin response…), the same sensed data are able to be mapped to generate direct stimuli as feedback, for example in response of an aroused state to keep a participant aroused or to de-stress.

This research has been referred to as a form of biofeedback in that under a mixed methods approach both qualitative and quantitative analysis can be implemented: Data that is sensed from a human body can be mapped to trigger and effect feedback stimuli that in turn can affect the participant: The affected participant reacts to the stimuli by subsequently generating data to again trigger and effect. This causality is referred to as the human afferent efferent neural feedback loop closure, and is seen

1https://www.bristol.ac.uk/carehere.
as a powerful motivator within (re)habilitation and situations associated to well-being. An emergent model on optimised motivation from the research is reported in Brooks and Petersson [11]. Aligned to the emergent model is that correlations between sensed data can indicate differences in reactions to specific stimuli to aid setup design and pre-sets.

A contemporary example of biofeedback is where miniature cameras can be positioned inside a Head Mounted Display (HMD) to generate videos of what aspect of a created visualisation is being looked at and at the same time what is the emotional reaction of the person to what is being looked at. Within the headset this can be via additional miniature cameras that capture pupil dilation and additionally other signals can be sourced such as mentioned above (heartbeat, galvanic skin response, brainwaves…). With such a setup, a designer of an experience (virtual/augmented) can research human responses to a media creation and adjust accordingly. Thus, subsequent designs being informed from a user’s specific experience.

In this chapter, HMDs were not used with the two PMLD participants so that full facial reactions were observable to indicate emotions associated to the experience of the multisensory stimuli.

In line with inclusive well-being, participants in the applied research to date span across ages (children, adults, aged) and across ranges of (dys)functional ability and diagnosis. Thus, a catalyst of the body of work is as a supplement for traditional intervention targeting impact in (re)habilitation.

The work has also researched outside of (re)habilitation where the VIS multisensory environments, including biofeedback setup, have been used in context of installation and performance art. From these contexts learnings have been impactful for the (re)habilitation and inclusive well-being aspects as well as the multisensory multimodality aspects. In a similar fashion, the healthcare activities inform the art context.

This chapter, alongside presenting the two case studies with participant end-users, additionally comments on the thinking behind ‘VIS-based multisensory interactive vibroacoustic therapeutic intervention’ and related practical implementations of such empowering technologies to realise meaningful experiences for end-users as found in this research. Input from noteworthy luminaries in the field are extensive for clarity of association to this work and to position in the field.

‘End-users’ as a term used in this field to include beyond the participant/patient/client, who in this research is considered central. The term is used to additionally refer to session facilitators who may be therapists, individual carers of participants, or other healthcare professionals: Family members and friends can also be referred to as end-users in context of the participant’s shared systemic experience, for example where co-playing a game such that social interactions are targeted. In other words, the term is encompassing of all those who are using the system at a given time. The next section introduces the multisensory setup.

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2 https://pupil-labs.com/products/vr-ar/.
17.3  Multisensory Stimulus: Sound, Sound Therapy, Music Therapy, Vibroacoustic Intervention

Raghu [51] informs how:

Sound is a form of energy produced by vibrations caused by movement of particles. Sound can travel through solids (such as metal, wood, membranes), liquids (water) and gases (air). The sound vibrations that reach our ear are produced by the movement of particles in the air surrounding the source of sound. The movement or vibration of particles produces waves of sound. Sound waves are longitudinal and travel in the direction of propagation of vibrations. The pitch of sound is related directly to its frequency, which is given by the number of vibrations or cycles per second. The higher the pitch of sound, the higher is its frequency, and the lower the pitch, the lower is its frequency. Human ear can hear sounds of frequencies ranging from 20 – 20,000 cycles per second (or Hertz – Hz). Sound waves can be visually seen and studied using ‘Chladni’ plates… //

Sound is everywhere. There is perpetual movement and action in the world around us, and this produces a variety of sounds, such as those coming from Nature, from animals, those generated by humans in the form of speech or music, those that are generated by vehicles, machines, gadgets that are used for comfort, leisure and convenience. What is interesting or important about Sound? Sound is an integral part of our lives. Whether we like it or not, the vibrations of these sounds reach us, not only through the hearing sense, but also by coming into contact with the physical body. The sound vibrations can affect us either positively or negatively, entering into our being, via the physical, mental and emotional realms, thereby affecting our consciousness as a whole. Therefore, while it is important, it would also be interesting, to know more about the nature of sound, how it affects us, and in what way we can harness it positively and try to reduce its negative impact on us. Raghu [51, p. 75].

There is abundant literature on using sonic/audio (and/or visual) responsive feedback in (re)habilitation including the author’s archive covering publications, projects and activities spanning multiple decades—accessible at https://vbn.aau.dk/da/persons/103302. These responsive feedback stimuli are established within a created modular environment that can be tailored to an individual profile. The conceptual environment is referred to as Virtual Interactive Space (VIS) and was first published in 1999 at the World Congress for Physical Therapy (WCPT) in Yokohama, Japan.

There is also much literature on vibroacoustic therapeutic intervention (see next section) where various terms are used—such as Vibroacoustic Therapy (VAT) e.g. [50], Vibroacoustic Music (VAM) e.g. [64], and Vibroacoustic Sound Therapy (VAST) by Ellis (2004).

The two case studies presented herein are cautiously positioned in relation to this literature above. This is stated as VAT and VAM both use specific low frequency auditory impulses (30–120 Hz or musically approximately B0–B2), either as stand-alone or mixed within music: Both are reported within context of ‘Music Therapy’ discipline. Aligned, [43] offers in-depth reflections on emotional music therapy relation across pre-recorded music and musical improvisation.

Ellis’ (2004) VAST study, and related research, does not argue position in music therapy literature—rather arguing against such inclusion.
This is potentially why Ellis’ (2004) study does not state specific what is used in the vibroacoustic sound therapy cases apart from a Soundbeam™, a chair built with audio speakers inside, and a music recording (but no detail to the content of either MIDI or recording being focused upon low frequencies).

The two case studies presented herein, as well as the author’s holistic work overall, are positioned aligned more with Sound Therapy [20, 25, 59] (Ellis 1995) than Music Therapy approaches to Vibroacoustics e.g. [50, 64]. This is because in the case studies there was no focus on restricting the tonal range of audio to 120 Hz and below using solely sine wave tones (both participants enjoyed range of sounds and effects) and no melodic or harmonic form was targeted.

Also, the author is aware of the Sound Therapy’s work with visual stimuli aligned to Soundbeam triggering of audio—thus the ‘thinking’ on multisensory stimuli aligns with Ellis and the Soundbeam personnel.

In the next section [20–25, 27, 28, 59] are sourced extensively in elaborating on the Soundbeam and the Sound Therapy approach.

### 17.4 Soundbeam and Sound Therapy

Soundbeam³ is a linear ultrasound sensing of movement device that triggers MIDI notes (which is typically wide span of frequencies depending on MIDI patch selected and range of notes programmed). It has been a leading product in the field for approximately thirty years with units sold globally and a network of therapist users. Ellis in his research [20, 25] (1995, 2004) primarily used Soundbeam with MIDI whole tone scale sounds in his reported research. Thus, he doesn’t classify his research specifically as music therapy: see [59], who explains Ellis’ approach and Music/Sound Therapy eloquently:

In traditional music therapy, the less the child is able to say something with sound because of a physical or cognitive disability, the heavier becomes the therapist’s responsibility for empathy and interpretation. The main focus and engine for the mood and meaning of the music which is happening is on the therapist, and this creative and interpretative role is increasingly shifted away from the child with more profound levels of disability. Consequently, as the liberating potential of musical expression increases, it becomes correspondingly less achievable. This allocation of creative ‘power’ may have no clinical or therapeutic rationale, it may simply result from what is physically possible.

Swingler [59, np].

In justifying use of the Soundbeam he adds:

The experience of initiation is central to the success of Soundbeam, especially for individuals with profound disabilities. If ones overall experience of life is essentially passive, it may be difficult to develop any concept of ‘selfhood’, any idea of oneself as a separate individual. What Soundbeam offers, perhaps for the first time and regardless of the individual’s degree of immobility, is the power to make something happen. This is the vital experience of “that

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³https://www.soundbeam.co.uk.
was me!”, which can function as the foundation stone for further learning and interaction. This use of sound as the source of motivation is an extremely simple but crucially important application of the technology; it is impossible to overstate its value.

Swingler [59, np].

Swingler [59] elaborates on how [20, 25], Ellis (1995) one of the most prominent Soundbeam researchers, established a systematic long-term evaluation of Soundbeam’s potential for children and adults with disabilities. In sharing the technique of use he states that the Soundbeam device (the sensing ultrasonic beam) “is positioned so that as soon as the child begins to move an interesting sound is triggered, motivating further movement and, eventually, radically enhanced posture, balance and trunk control.” Due to individual differences and handicap profiles quantitative measures are rarely implemented—though given contemporary computer vision technologies and related software it is possible to measure using an automatic extraction of motion cues—what Camurri et al. (2011) relates as QoM of Quantity of Motion including contraction and expansion (CI), Kinematic cues and more (—see pp. 25–27, also [11].

Also relative to the author’s research is how Swingler [59] states—“All of this is accomplished in parallel with a strong sense of fun and achievement. For the child, the therapeutic dimension of what is happening is irrelevant”. Importantly, relating to this chapter author’s research is the term “For the child” as the therapeutic intervention being targeted is considered a facilitator layer of knowledge that is not needing to be conveyed as it could demotivate if targeted formal ‘clinical’ goals in a session were not achieved.

Swingler [59] further posits how in Ellis’ use of Soundbeam:

….Sound itself is the medium of interchange… This approach contrasts with traditional models of music therapy, with its emphasis on ‘treatment’, direct intervention and imposition of external stimuli determined by an outside agent. Even where a music therapist may claim to be ‘responding’ to a patient’s music, this is a personal response on the part of the therapist. Often the therapist uses, or moves towards, a traditionally based musical language comprised of melody, harmony and rhythm, so limiting the soundscape and genre of ‘musical’ discourse. The ‘patient’ or ‘client’ is viewed in a clinical way, with a condition which needs to be treated or ameliorated. There are clearly defined goals with these treatments, with success measured according to how effective the treatment has been in terms of the clinical or medical condition. The modus operandi of these approaches is essentially from the outside -in, with an emphasis on clinical intervention rather than independent learning.

Swingler [59, np].

In considering the composition of the human body and that approximately sixty percent is water related, it is not a surprise that sonic frequencies have an effect on its inner structures movement. As composition structures, such as cells, atoms and molecules, are agitated by the sonic waves, increased interactions and communications take place as a result of deep cellular stimulation that some claim results in harmonious and healthy resonances that are restored to the body. 5

Raghu [51] informs on tone relationships:

4https://en.wikipedia.org/wiki/Composition_of_the_human_body.
5https://www.vitalhealthcare207.com/index.php?p=504881.
Sound vibrations can come in contact physically through the body and have an effect on our consciousness at the mental, emotional and spiritual levels. Sounds that are musical can be categorized as consonant sounds that are pleasant, and dissonant sounds that are unpleasant or not so pleasant. Musical sounds are comprised of notes in increasing or decreasing order of pitch (frequency). The interval between notes can give rise to consonance and dissonance. Example, an interval of an octave - a range of seven notes - is said to be consonant, whereas an interval between adjacent notes can be dissonant. These are studied by experimenting with musical notes and intervals, their visual patterns and their effect on consciousness. While consonant intervals can cause happiness, joy, courage or calmness, dissonant intervals can cause tension, anger, fear or sadness, thereby affecting the emotional aspect of consciousness.

Raghu [51, p. 75].

Here we can look at Ellis’ decision to use whole tone scale intervals and issues such as beats, resonance and entrainment.

Raghu [51] informed on the topic of ‘beats’ that:

When two (or more) sounds are produced having a frequency difference of less than about 20 or 30 Hz, you will hear “beats.” The frequency of the beats will be at the difference frequency. If the frequency difference is larger than about 20 or 30 Hz, a tone is usually perceived rather than distinct beats.

Raghu [51, p. 78].

On the topic of ‘resonance’ [51] posited how:

A musical instrument can be forced into vibrating at one of its harmonics (with one of its standing wave patterns) if another interconnected object pushes it with one of those frequencies. This is known as resonance - when one object vibrating at the same natural frequency of a second object forces that second object into vibrational motion. The word resonance comes from Latin and means to “resound” - to sound out together with a loud sound. Resonance is a common phenomenon of sound production in musical instruments.

Raghu [51, p. 78].

On the subject of ‘entrainment’ [51] shares how:

This involves changing the natural vibrational frequencies of an object and replacing them with different vibrational frequencies of another object, thereby actively changing the vibrations of one object to that of another object. Entrainment is considered as an active method, whereas resonance is considered as a passive method. (Healing Sounds, n.d.).

Raghu [51, p. 78].

Sound qualities such ‘beat’ ‘resonance’ and ‘entrainment’—as pointed out by [51] align to the author’s holistic body of work titled SoundScapes [8] and the positioning behind the topic of Aesthetic Resonant Environments (see also [10, 14, 21–28, 35,...]) where variations of the term is elaborated by different authors but with an aligned red thread of meaning.

Acknowledged by Raghu [51] regarding musical/bichordal intervals and effect is that:

One of the reasons why listening to music is so healing for us, is due to the power of musical intervals. A musical interval is created when one note is played with another note. The interval can be created by playing two notes together, or one after the other. When two notes are played together the interval has a stronger effect on us. The frequencies of the two notes
of the interval create a mathematical ratio that affects the body in different ways. When we listen to all the intervals in the musical scale it is profoundly healing for our body and our mind. Pythagoras discovered that the ratios of the musical intervals were found in nature, the planets and constellations. (Simon, H., n.d).

Raghu [51, p. 78].

Ellis’ research [20, 25] (1995) tended to use whole tone scales that may align with how the notion that each musical interval has a unique psychological effect has not been fully determined (e.g. [44, p. 309]) and affect may differ cross-culturally and situation [45]. Further, [16] offer findings from a factor analysis groupings analysis of bichords and music focused upon three aspects (1) emotional evaluation, (2) activity, and (3) potency, where factors 1 and 2, proved to be most significant related to interval discrimination (p. 4). This [16] study (and linked in text) points to gender differences aligned with different emotional affect intensity—something not discussed in the two case studies in this chapter where one was male and one was female.

This section has focused on the auditory stimulus—the next section introduces the selected visuals.

17.5 Multisensory Stimulus: Visuals—Case Studies 1 and 2

In the case studies presented, two forms of interactive visualisations were predominantly used.

The first interactive visual system used MIDI messages controlling a software synthesiser having three oscillators. Each oscillator could be selectively mapped to control channels on [a] an additive colour wheel i.e. (1) Red, (2) Green, and (3) Blue, where 0.00; 0.00; 0.00 values equate to black and 1.00; 1.00; 1.00 equate to white: or [b] an alternative colour wheel controlling channels of (1) Hue, (2) Saturation, and (3) Value (or intensity or brightness) where white and black are added to the colour to adjust.

Patterns were programmed into the synthesiser so that geometric shapes are generated that are then ‘painted’ by adjustments to three MIDI continuous controllers (CC) where each is assigned to control one oscillator (1, or 2, or 3).

A continuous controller is a specific MIDI message capable of transmitting a range of values, usually 0–127—images as fully illustrated in Fig. 17.1 (on left wall) and Fig. 17.2. A video illustrating hand gestures of a choir conductor creating the images with three infrared sensors is available at https://www.youtube.com/watch?v=65gAT_RAfvU.

The second interactive visualisation system used camera capture of participant where the image was processed in a software algorithm (Eyesweb6) to reflect a selectable threshold of movement quantity and quality that generated a form of ‘blobby’ ‘abstract’ digital painting. The participant could select which Soundbeam (ultrasound beam) he moved within to generate selected sounds and where the same

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6https://www.infomus.org/eyesweb_ita.php.
Fig. 17.1 Author (right) setting up a multisensory Interactive Vibroacoustic Therapeutic Intervention system for female participant M who is lying on a vibroacoustic Soundbox™. This has embedded speakers that produce tactile stimulus for her experience of auditory feedback responding to movement that M activates by her motions within three volumetric infrared sensing spaces. Attending mother (next to open door) looks on, with one staff member arranging video camera and another positioned prepared to observe. Visualizations (geometric shapes in this case) that M triggers through her movement can be seen projected onto left wall facing M. A Microphone is directed to M to capture session utterances that are processed in an effect unit. Computer workstation is at the rear of the room where all data/stimuli is sourced and mapped to visual synthesiser software with output to projector

motions generated the digital painting image Fig. 17.3. Examples of images from this research is shown in Fig. 17.4.

17.6 Multisensory Stimulus: Tactile/Haptic = Vibroacoustic Therapeutic Intervention

Vibroacoustic therapeutic intervention has been practiced under different titles by an array of people for many years in different forms and in differing settings for a variety of patient profiles and conditions e.g. physical, emotional, mental. Music therapy has been conducted primarily by musicians such that “the dominant approach to the field has been subjective and founded in artistic and literary traditions” [64, p. 14]. Punkanen and Ala-Ruona [50], in their article abstract in the journal Music and Medicine, state how:
**Fig. 17.2** Movement by end-users (participants with handicap) within three infrared sensor zones that are mapped to different MIDI CC channels controlling colours that ‘paint’ the different generated geometric images. Purposefully, the participant is positioned ‘inside’ the image (if possible) for a heightened sense of immersion (see [10]).

**Fig. 17.3** (Left) Male participant R seated upon Soundbox with original camera image upper right on screen; first stage of processing in Eyesweb algorithm—lower right on screen; Digital painting (upper left); (Right) Soundbox with desk and a variety of switches. Behind desk are two Soundbeams and central video camera. Altuglas Black and White projection screen behind [36].
Vibroacoustic therapy (VAT), traditionally considered to be a physical and receptive type of music therapy intervention, uses pulsed, sinusoidal, low-frequency sound on a specially designed bed or chair. Today VAT is viewed as a multimodal approach, whereby the therapist works with the client’s physiological and psychological experiences, incorporating a mind–body approach.

Punkanen and Ala-Ruona [50, p. 128].

Credit for the VAT concept is acknowledged to Olav Skille and Juliette Alvin from 1968 in relation to development of a music therapy model. Evolution of the model is again credited (ibid.) to Skille from his 1982 definition of VAT as being:

…the use of sinusoidal, low-frequency (30–120 Hz), rhythmical sound–pressure waves mixed with music for therapeutic purposes/considering/ “low-frequency sound massage” would assist in the reduction of pain and other stress-related symptoms.

Punkanen and Ala-Ruona [50, p. 128].

A range of literature point to favourable outcomes from vibroacoustic therapeutic intervention, for example with patients having fibromyalgia [47], children with profound and multiple learning difficulties and the elderly in long-term residential care (Ellis 2004); spasticity and motor function in children and adults with Cerebral Palsy [40], and more.

Whilst Skille is reported to have initially focused VAT on using a single amplitude modulated sinusoidal sound, and later incorporating music—at around the same time, a research professor from Aalborg University Denmark, Tony Wigram, mixed music and low-frequency sound, which he named “vibroacoustic music” (VAM)—(see [64]). However, these definitions would seem to overlap and confuse as both VAT and VAM apparently use similar content i.e. single amplitude modulated sinusoidal sound plus music. Subsequently, Ellis (2004) coined the term Vibroacoustic sound therapy from use of whole tone scales of sounds routed to a vibroacoustic chamber or chair—thus there was no melody, harmony and structure as one would relate to musical form (see elsewhere in this chapter for more on Ellis’ ‘Sound Therapy’).

Whilst literature points to benefits from vibrations impacting the human body (see elsewhere in this chapter), however, care is needed when using vibroacoustic systems.
as whole-body vibration can cause weariness, digestive troubles, headache, imbalance and tremor shortly after or during exposure. Special Interest Groups (SIGs) such as VIBRAC, the Skille-Lehikoinen Centre for Vibroacoustic Therapy and Research which was founded in 2012 and is managed by The Eino Roiha Foundation under the University of Jyväskylä, Finland instruct on best practice. Unfortunately, the VIBRAC site’s last update is seemingly 2016 as of writing, suggesting a lack of activity. However, this comment may be premature, as there is apparently a renewed activity and networking being initiated (2019–2020) following the author’s contact to the leadership but the Covid-19 situation prevented the VIBRAC SIG meeting at a conference in Boston USA—it is anticipated that this group will reinvigorate the field and collaborate with this author to advise best practice, tools, and to explore the interactive vibroacoustic therapeutic intervention as posited herein. The next section introduces VIBRAC and the field.

17.7 VIBRAC and Review of the Field

A dedicated Vibroacoustic Therapy facility was established in 2012 in Jyväskylä, Finland, namely VIBRAC Skille-Lehikoinen Centre for Vibroacoustic Therapy and Research, under the Eino Roiha Foundation. The centre is recognised as a development, training, and research centre for Vibroacoustic Therapy (VAT). In reported research at the site it is stated how “effects and benefits of VAT have been originally linked to high muscle tone and reduction in spasticity.”7 The site informs on an array of conditions where positive treatments have been reported—however it also makes clear that:

The typical shortcomings in most studies relates to design, small sample sizes, and poorly described interventions which are not based on best clinical practices, as well as the inability to find applicable and sufficiently sensitive measurement tools. Future research should focus more on improving the practices and reporting of VAT, and studying the effects of the most relevant clinical interventions and procedures for the clinical groups which seem to benefit most from this particular intervention. Special attention should also be given to the measurement tools used in VAT studies.

https://www.vibrac.fi

In line with this statement, it can be considered how the research presented herein—the two case studies—aligns with such shortcomings, however, the goal of this work was not to treat or measure clinically. Rather it was to study potentials to supplement auditory with additional stimuli from a position argued aligned with individual differences, preferences, needs and desires. This a position argued in line with Ellis [20, 59] (1995, 1995, 2004) contributions as quoted elsewhere in this chapter.

7https://www.vibrac.fi/content/research-vibroacoustic-therapy.
17.8 Conclusion

Two case studies are presented to exemplify the concept of multisensory interactive vibroacoustic intervention in a VIS environment. Teenagers of similar age and similar condition with one being male and one being female were the participants. Invisible sensors using ultrasonic and infrared technologies were used to capture participant movements that were mapped to auditory, visual and tactile feedbacks—all experienced as synchronous. Evaluations were highly positive by involved staff and family. Sound boxes such as used in these case studies offer opportunities to stimulate participants with severe dysfunction to have rewarding and enjoyable experiences that whilst being fun can also lead to formal therapeutic outputs. In this work reports of less spasming, increased contact to staff, happier disposition and more beneficial outcomes are reported (e.g. see [8, 20–26, 59] Ellis (2004).

These two case studies did not use specific low-frequency content as in VAT or VAM. Audio content was rather across the whole range of frequencies and typically the chromatic scale was used (as opposed to Ellis’ use of the whole tone scale). Justifying this choice is that the chromatic scale offered a higher sensitivity/resolution (more notes in the invisible sensing space) to challenge smaller motion triggering to challenge increased precision of gestural control.

The use of interactive environments where tones are composed through gesture relates to Stokowski who in 1932 predicted “a time when musicians would be able to compose directly into TONE, not on paper. In other words, we would be working directly with sound itself rather than with the symbols used to represent the results of imagined combinations of sound” [59].

17.9 Future Research in Interactive Vibroacoustic Therapeutic Intervention

The author anticipates gaining additional knowledge of best practice in this field alongside developing skills and competences associated to tools and practice toward increased research in this field to test against VAT and further music therapy interventions (e.g. [43]). This means specific research on content feedback stimuli to ascertain differences aligned with literature cited herein—so for example use of a specific range of frequencies and mapping to sensors. A stumbling block over years has been that the research has not received funding specific to the vibratory research—and this has meant it has been almost stagnant for a number of years. However, once funding is in place, next plans (after discussion with experts at VIBRAC SIG to best practice, health and ethics) involve to add to the modularity aspect to test different sound boxes (vibroacoustic chambers) with larger speakers to increase amplitude of vibrations. This plan involves using specialist bass frequency speakers in different combinations, primarily testing from 10-, 12-, 15- and 18-inch units, in combinations of 2, 4, 6, 8 and 12 speakers. The speakers will be positioned on their backs...
in a bespoke assembly with a support board resting on the top for participant to lie on. Combinations are planned to be fed from different amplifiers in order to explore digital vs valve (tube) based amplification of sound. Testing is planned for this aspect to include blind and deaf to study any differences in tactile stimulus felt between the analogue and digital amplifications and to test if outcomes impact PMLD tests.

The systems are planned to test additional devices to trigger and manipulate the auditory stimulus. These include music floor pedals to further empower and enhance self-control over the sound ([6], figure 9). These pedals include specifically the Moog Taurus III Foot Pedal Apparatus, an analogue monophonic synthesizer that has 13 large velocity-sensitive wooden church organ style pedals, which due to size, thus can be played by appendage beyond the feet. The Moog Taurus III sounds are generated by two sawtooth oscillators, a multiwaveform low-frequency oscillator, and has a 24 dB/oct resonant low-pass filter to emphasize low frequencies in the selected patches for increased tactile feedback in active vibroacoustic situations. The Moog also has an arpeggiator that can play back patterns of sounds from a pedal press.

Guitar/Bass effect pedals are also planned to be incorporated to additionally enable a participant to ‘effect’ parameters of the sound that is experienced. This can also be a second participant so that sounds are ‘manipulated’ together. For example, these will range from subtle compression, chorus, reverberation, and echo to more distinct changes such as distortion, envelope follower, octave splitter, and more. Additional interfaces such as ultrasound sensor grids; touch strips; cross-hair tracking; and rubber electronic drum pads are also planned to be tested attached to sound boxes. With so many interfaces available, alongside software to manipulate content there is a wide gamut to research under this subject that deserves increased attention.

17.10 Postscript

In closing it is pertinent to reflect on an experience from April 2008 from a workshop that the author conducted at ‘Casa da Música’ (CDM), Oporto, Portugal [7]. The workshop was in the form of an interactive installation/environment built in the location in the concert house rehearsal room for the national symphony orchestra—approximate dimension, 238 m² floor area, 20 m high (where there was notably a wooden sprung floor for players to feel the music through their feet). A large ‘multi-room’ interactive multisensory setup was designed by the author and built with the technical crew. Large sub-woofer speakers were distributed around the room—this to impact the sprung floor with maximum vibrations from music generated by motions in the spaces. The workshop was titled “Ao Alcance de Todos Música” (Within Everyone’s Reach). Attendees were from regional special needs institutes, schools and hospitals, as invited by the CDM education department who organised and arranged the annual event. Attendees were across ages and handicap. Workshop attendance groups were of about twenty persons. One group attended from a local institute for the deaf. All attendees were asked to remove their shoes at the entrance.
The memorable experience was where a young boy about eight years-of-age who couldn’t hear found the “hot-spot” of sensors such that he was controlling audio and visuals with miniscule movements. Other attendees stopped to watch him as he started shaking emotionally in a positive fashion exploring what he had found. The author instructed all to lie on the floor and to watch the boy. The experience was enlightening and illustrated potentials of interactive vibroacoustics in therapeutic contexts with multisensory stimuli options. Such modular system setups allow mixing and matching of components to an individual participant’s profile (e.g. his/her preferences, needs and desires to enjoy and have a fun entertaining episode) aligned to the therapeutic output (therapist/facilitator targeted formal outcome for the participant) to thus enable a tailorable biofeedback experience of the self for the participant having developmental potential.

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