Listening to the Body's Excitations
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Listening is often described as hearing with a purpose, and thus to listen often means to absorb information or to understand someone's emotions in order to respond appropriately. But while such purposeful listening is necessary and useful, it certainly is not the only kind of listening. In fact, it is a constructive and instructive exercise to, every now and then, self-observe and consider where our listening attention is really directed. Doing so can lead to profound insights, for example confronting us with the selective (and therefore partial) nature of our listening, or the motives that drive our listening efforts in particular situations or with particular conversation partners. Moreover, reflecting on these observations with greater detachment makes it possible to shake off some of the thought constraints engrained by our habitual listening preferences. From this perspective we can see how the practice of detached listening can be an important training method for performance practices. In some cases, it may even form their core focus.

While many artists explore the act of listening, a particularly significant contribution has been made by composers and performers working with biofeedback: the real-time monitoring of the physiological processes of a human body by means of sensors. The data that is so gathered can be further processed, using the physiological data to create electronically produced sounds or images. Since the 1960s performers and composers have employed biofeedback technology to focus on self-observation or self- reflective listening. For example, pioneers of electro-acoustic biofeedback composition, such as David Rosenboom and Alvin Lucier, made the experience of becoming conscious of one's own listening the centre of their earlier practices; this is captured in Rosenboom's *Biofeedback and the Arts* (1976).

Excitations is the title of a recent biofeedback work that explores the nature of listening through a sound feedback loop. It was developed in iterative stages between 2005 and 2010, and exhibited in performance and in participatory sessions. For the sessions, participants were dressed with biofeedback sensors, and introduced to the real-time sonification of their stress levels and heart rates. Hearing these sounds makes one aware of physiological sensations of the body that usually go unnoticed, such as the pulsing of arteries or the tension and sweating caused by stressful thoughts. However, since the sensors also pick up one's physiological reactions to the sounds (called 'excitations'), these too become audible. *Excitations* therefore not only continuously externalized subtle physiological processes, but also introduced participants to a somewhat vertiginous listening situation: they experienced themselves as the producers of the sound sensations and simultaneously their prime recipients. Focusing on this could create a self-reinforcing feedback loop that would immerse participants deeper and deeper into the emerging sounds.

For this to be successful, the sound composition had to translate the physiological data in such a way that the relationship between performing body and sound remained intuitively perceptible to the participant. Practice revealed that too much as well as too little data sonification made it difficult to separate more significant sound events from the general 'noise' of sonified activities, and the relationship between performing body and sound became unclear. Thus it became

important to sonify only a certain amount of data, and to select a sonification method that could map the incoming biofeedback data perceptively, generating sound structures with easily recognizable characteristics. In other words, the sounds generated for *Excitations* had to avoid appearing as overly simple or overly complex. Moreover, to convey the notion that in *Excitations* one is listening to a transformative and open-ended process, the sounds had to be somewhat unusual and unpredictable, but still remain mostly within certain parameters. This approach could be likened to working with complex generative systems, which are neither completely chaotic nor completely ordered.

Delalande (1998) describes listening to music as involving several behaviours, which comprise taxonomic listening, emphatic listening, figurativization, search of law of organization, immersed listening and non-listening (see Figure 1). However, while it is impossible to generalize how sound events are listened to, certain sound characteristics may well bring particular listening behaviours to the fore. For instance, if a musical structure mutates over time, listeners might be likely to listen out for the laws of transformation. The use of spatialised sound, on the other hand, may encourage immersed listening. Certain sound timbres, or chords, may provoke stronger emotional responses than others, while complex metres may draw attention to the rhythmic structuring of a piece. Thus a composer's skilful use of compositional strategies can influence the listening process.

Taxonomic listening	trying to understand the form and structure of what is heard
Empathic listening	becoming aware of immediate reactions to what is heard
Figurativization	searching for a narrative discourse in what is heard
Search for law of organization	searching for rules that define what is heard
Immersed listening	feeling part of the context while listening
Non-listening	having lost interest or concentration

Figure 1: Delalande's listening behaviours (1998), as expounded by Landy (2007).

This notion is also supported by Huron (2007), who applies concepts from evolutionary psychology and cognitive science to music perception. Huron describes the psychological mechanisms of listening in terms of a five-part emotional response system. The first of these occurs when a listener merely imagines sounds being played. A second takes place when the expected sound events are imminent and the body reacts with a tension response. As soon as the sounds are perceived, the third response takes place: an immediate physiological reaction, unmediated by conscious thought. Together with this, a fourth prediction response occurs, which assesses the accuracy of the listener's expectation. The fifth and final appraisal response takes place once the whole situation has been sufficiently absorbed.

Describing listening as behavioural patterns or a response system can be useful, allowing for a more focused application of compositional tools, as well as the framing of listeners' encounter with the sound. However, it becomes problematic if it is assumed that listening is always voluntary and taking place without distractions. Realistically, one needs to acknowledge that most listeners' efforts vary, fluctuating between different kinds of listening. Often this is ignored, but in *Excitations*, where biofeedback sensors pick up fluctuations in participants' emotional states, the sounds can also reveal the listeners' levels of engagement with the sounds: the 'real' listening process itself becomes a feature of the work.

However, quite what participants hear in *Excitations* and how they perceive the sounds affects how this self-reinforcing process works. To understand what is meant here, it is useful to look at two of the sonification processes in greater detail. Heartbeat data, which is traced via an electrocardiogram sensor, can be described as rhythmic; it is a continuous stream with regular accents. It may seem rather obvious to maintain this rhythm in the sonification process. However, doing so is useful, since listeners intuitively know what this kind of rhythm represents, and it becomes more noticeable to them when variations or irregularities occur within the heartbeat sonification. Focusing in on these smaller changes already signifies that a deeper kind of listening is taking hold.

In contrast, when mental states are measured via galvanic skin response sensors or electroencephalograms there are no such obvious translations. Since listeners are not used to hearing their mental states sonified, they have to listen out for the sounds that are assigned to these and, at least initially, consciously observe how the sounds alter as their feelings change. In Lucier's Clocker and Music for Solo Performer, percussive sounds were chosen to represent different mental states. In Music for Solo Performer, Lucier used his brainwave patterns – measured via an electroencephalogram – to set off percussion instruments in the auditorium; in *Clocker* he used his galvanic skin response to influence the speed of an amplified clock. In *Excitations*, however, this sonification precedent was not followed. Here the aim was to relax participants with the sounds in order to lead them towards deeper and more detached listening experiences. Collaborative practice with listeners revealed that representing mental states with percussive sounds did not relax them. Extended diatonic chords, on the other hand, were relatively quickly perceived as relaxing. This preference is interesting, as it also shows a possible correlation with the data obtained; stress levels could, for example, be described as a continuous data stream with very small variations that occasionally undulate by larger degrees, like the rippling surface of water that is affected by larger waves, or possibly like extended chords inflected by inversions and modulations.

Regardless of the kinds of sound chosen, however, practice revealed that the participants in *Excitations* could better immerse themselves in the listening process when the sounds were sufficiently disconcerting to disrupt habitual listening, but pleasant enough to prolong interest. If sounds were perceived as too unusual, participants focused in on them, eventually losing the connection with the physiological processes to which the sounds were intended to draw attention. Yet if the sounds were perceived as too ordinary, listeners lost interest.

Perhaps because diatonic chords are common in music that follows the Western classical tradition, those chosen for *Excitations* provided the necessary familiarity for listeners to focus in on the internal tensions that became perceptible. This experience could then be intensified by letting the stress level data influence the chord structure. For example, an inverted A minor chord with added notes (sevenths, ninths and elevenths), used early on, evoked for most participants a sense of stability but also a sense of tension, which may have resulted from the chord's internal dissonances. According to participants' verbal accounts, the tension seemed to pull the sounds in many different directions at the same time, making it hover like a cloud of particles: apparently stable, but the less so the closer they listened. Later on, it was attempted to enhance this perception by inverting the chord whenever participants' stress levels changed, making the intervals of the original chord expand or contract. Verbal accounts of this practice stage established that while a close-knit note grouping could evoke a stronger sense of stability, a more dispersed one could intensify particular dissonances and make it 'sound more eerie'.

Thus while the chord generally evoked feelings of familiarity, its subtle internal tensions and ambiguities kept listeners alert. This sonification strategy seemed to work best when there was nothing specific in the sounds to indicate how much more relaxed/more stressed participants became but merely announced that a change took place: a significant simplification that discouraged participants from trying to control the sounds by conscious effort and shifted the emphasis towards the act of listening.

The fragile stability encountered by participants in *Excitations* became yet more pronounced when it was performed in a surround-sound setting. Here, two dimensions could exchange their core characteristics: small movements from inside the body could become enlarged to such an extent that they could fully absorb their listeners. Practice showed that this experience was perceived as destabilizing and became particularly effective when participants adopted more detached kinds of listening. Some participants reported feeling increasingly like they were part of a continuous, self-reinforcing feedback loop, unlike in their habitual experiences of sound perception. This could sometimes lead to feelings of vertigo, especially when participants began to notice their attention wandering between observing the sounds – comparing them, interpreting them, predicting them – and focusing on their bodies as their source.

This account indicates that sonified biofeedback can successfully externalize some of the physiological processes of the human body and lead to greater appreciation of their intricate nature. However it also hints at something more fundamental: that listening is a truly embodied activity that is reinforced by self-reflection. Listening to one's own sonified biofeedback can therefore be a means to practice the observation of one's own listening processes.

References

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