Behavioural ecologies in ubimus

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Abstract. *I address the contributions that ecologically grounded creative practice can make to ubiquitous music research. Despite its reliance on experimental data and its extensive epistemological underpinnings, the implications of almost twenty years of eco-compositional practice have not yet been thoroughly assessed. With the recent expansion of ubiquitous music practices, instrumentally based proposals are starting to show their limitations. What set of conceptual tools will replace instrumental music theory is still an open question. In the second section, I try to identify several new methodological issues brought up by ecologically grounded creative practices - including recent applications in instrumental music - and point to major contributions made by well-documented artistic projects, including the concepts of events, activities and ecologies. The third section of the paper deals with the main topic of the text: ubiquitous music behavioural ecologies. Behavioural ecologies for creative practice can be defined as systems that shape and are shaped by human behaviour. Although several related concepts have appeared in the recent literature, none of these address the problems of value and the imprint of human action on the resources and the potentials for creativity. Based on the research questions raised by cognitively motivated theories of music and exemplified by the creative results of ecologically grounded artistic projects, I discuss a working definition of behavioural ecologies within the context of ubimus artistic applications.*

1. From formalism to embedded-embodied creative practice

By the end of the nineties, moving closer to an organic methodology for sound art (as idealized in the 1930s by Edgard Varèse), ecocompositional approaches proposed creative actions as by-products of action-perception cycles. The eco-compositional perspective rested on the pillars provided by embedded-embodied cognition [Gibson 1979; Hutchins 1995; Varela 1992]. Rather than abstract manipulation of symbols, composition was thought as interaction among agents and objects [Keller 1999a; 2000]. Eco-compositional activity involved the exploration of the local resources as key creative ingredients [Burtner 2005]. Similarly to the soundscape approach [Truax 2002], it incorporated *place* as a creativity factor highlighting the interaction with the environment as one of the central aspects of the creative process. Open-ended compositional methods were devised to turn musicians [Nance 2007] and audience [Keller 2000] into active participants of the creative process. This increased reliance on (1) social interaction, (2) everyday settings, and (3) open-ended, exploratory activity underscored the limitations of the existing tool-set for creativity support.

During the first decade of the twenty-first century, several composers started a search for methods to handle action-perception cycles within their compositional practice. Barrett (2000), Opie [Opie & Brown 2006] and Harris (2009) developed data-

extraction techniques that provided tools to deal with the complexity of the local sonic resources for musical purposes. Burtner (2005) explored the usage of synthesis techniques in external settings as sources of creativity, coining the concept of socio-synthesis. Di Scipio (2008) employed the venue's acoustical properties to increase the available resources for performance-based compositional systems. Nance (2007) proposed the use of aural scores as a way to increase the openness of instrumental works. Cádiz (2012) employed ecologically based synthesis methods in the context of orchestral works. And Basanta (2010) and the Capasso+Keller+Tinajero Collective (2000; 2004; 2012; 2013; 2014) made use of ecologically based interaction techniques to enhance the creative participatory potential of their installation artworks. All these initiatives have contributed to the methods presently gathered under the rubric *ecologically grounded creative practice*.

2. Structural coupling, pattern formation and emergent properties

Through a series of artistic projects done by the Capasso+Keller+Tinajero Collective during a five-year period (1997-2001) [Keller & Capasso 2000], several shortcomings were identified regarding the existing theoretical tools employed in creative practice. The undue stress on creative products, previously uncovered by Laske's (1989) research, was further questioned through an increased focus on creative potentials [Keller 1999a; Keller 2001; Keller & Capasso 2000]. Three interrelated concepts provided the basis to propose that ecologically grounded music making might deal with designing potentials, offering the possibility that part of the aesthetic decisions could be left in the hands of the audience: 1. structural coupling: the intrinsic relationships among resources and creative agents; 2. pattern formation: the dynamic space-time distribution of creative by-products which could be fed back into the creative process; and 3. emergent properties: the materializations of the pattern formation processes as aesthetic experiences. In 2001, after discussing the implications of the application of ecological models in creative practice, Keller synthesized those findings in these words: “[The ecological] perspective places the concepts of potentiality and actuality in musical meaning within the broader context of mutual determination between the individual and the environment. In this context, the interaction between the individual’s specific sonic experiences and the music’s structural processes establish a form-creation [dynamic] that brings forth an ever-changing history of meanings.” [Keller 2001: 10]. These conclusions were reached by bringing the proposals formulated by the embedded-embodied approaches to cognition into the field of creative practice. Francisco Varela's concept of *structural coupling* was a key piece in this framework.

Thirteen years later, Di Scipio (2014) adds a new twist to the structural coupling idea by proposing that ecologically grounded creative practices can be seen as a form of computation. This concept is based on Heinz von Foerster's (1973) notion of computing as a way "to consider or to contemplate things together" (from the Latin *computare*). Describing his piece *Condotte pubbliche*, Di Scipio (2014: 49) proposes “a gradual approach to a style of computation that does not so much take an input from the environment as it is rather coupled with the environment. We can describe this process at a meta-level, as a 'structural coupling' of so-called internal computations and so-called external physical conditions. In such a situation, computing becomes neither an entirely deterministic process, nor an indeterministic one, but a driving active part of a larger complex system. It yields less [...] 'resultant' output data, and more [...] 'emergent' patterns or behaviours.” Thus, the applicability of the ecological framework may be two-fold. On one hand, as proposed in [Keller 1999a; 2000; 2001; Keller & Capasso 2000], it considers interactions among resources – both social and material – and on the

other hand, it sets the stage for a hybrid form of computation integrated into the environment and very close to the concept of transparency proposed by Weiser (1995). For Di Scipio, rather than information processing, computing is about coordinating mutual exchanges of energy and information. Multiple examples of the implementation of the *exchange-of-energy metaphor* can be found in the ecological modelling literature. Let us take as example the sound work *Metrophonie* [Keller 2002].

The processes of accumulation [Keller et al. 2002; Keller & Berger 2001] and ecologically consistent timbre transformations inform the techniques employed to generate the sound material for *Metrophonie*. First, short samples – or grains – are extracted from the recorded sources. These grains provide the basic spectral and micro-temporal features of the sounds to be synthesized [Keller & Truax 1998]. Thus, a continuum from the recorded source materials to the events synthesized through ecological modelling is established. Short events, modelled after the characteristics of a chosen recorded sound event, are synthesized through constrained random distributions of grains [Keller 1999a; Keller 2000; Keller et al. 2002]. These models generate sound classes with ever-changing meso-temporal characteristics yielding events which are never identical to each other. Once the events are synthesized, they can be combined in two ways: *within-classes* and *between-classes*. Within-classes procedures provide events with a greater number of meso-temporal elements, adding depth and volume to the sound without changing its identity. Between-classes models create fusions and hybrids among the sonic sources, extending the sonic palette to the realm of the imaginary. This expanded sonic realm taps into paradoxes that can be described as *ecological dissonances*. These are events that abide by ecological constraints – they are possible on Earth – but are only rendered as aesthetic experiences. For example, the sound of coins falling into the subway turnstiles was expanded to suggest coins rainfall. Thus, various manipulations of money-related sounds provided one of the structural threads of the work. Resonant filtering was utilized to reinforce spectral peaks that were already present in the sampled sounds. The same technique was applied to change the spectral colour of unpitched events. Not surprisingly, most of the collected material exhibited a range of behaviours from harmonic stable evolutions to fast-varying temporally complex dynamics. Thus, most of the compositional work consisted of creating timbral bridges [Gordon & Grey 1978] among the environmental sonic classes provided by the sources.

Metrophonie can be described as an example of structural coupling at the level of computations: sonic characteristics emerge from the interactions among computational resources – in this case ecological models – yielding by-products that may be consistent with the original sources (*within-classes transformations*) or inconsistent with the original sources but ecologically plausible (*between-classes transformations*). As suggested by O'Callaghan (2013), the resources used in eco-composition may be considered an *ecology* of sound. While addressing the problem of transcription of environmental sonic events into instrumental music, O'Callaghan discussed several issues raised in eco-compositional practice. “Damián Keller has written extensively on the idea of adapting ecological models to musical structures. According to Keller (2001), in ecological modelling, variables are directly related to environmental processes such as excitation of resonant bodies, time patterns, etc. The range of possible values that these variables can take is restricted to ecologically feasible spans. Thus, a ball cannot bounce forever and a surface cannot be perfectly regular. These sounds provide cues to feasible events in the environment. It could be assumed that in the transcription of field recordings, these concerns are 'built-in.' To take Keller's example of a ball bouncing, if one is transcribing a recording of such an event, it might

be assumed that the transcription will not exceed or distort the natural pattern of the event, and will exhibit similar ecological feasibility." O'Callaghan (2013) thinks "this is true to a certain extent, [opening] a window into the notion that by transcribing environmental sounds, one is also transcribing 'an ecology.'" This is an important point. What O'Callaghan's work shows is that while transcribing events into musical notation, the *relationships* among the resources are more important than the abstracted isolated events. He argues that "there are many ways in which the transcription of such an event may truncate or otherwise obscure the ecological patterns suggested by the recording." Thus, he is interested "in abstracting these transcriptions into new contexts [or] in recreating a kind of parsimonious ecological frame for them. So, to continue with Keller's bouncing ball example – if the recording ends before the final bounce, and one is interested in integrating a transcription of this recording into a broader ecological frame, one may need to apply ecological models in order to 'compose' the termination of the ball bounce in a naturalistic manner." This application of the ecological framework captures one procedural aspect that has remained unnoticed: emergent properties may be elicited even if the sources are *decoupled* from their original ecological niche and the agents involved in the activity are different from the ones in the original ecology. Thus, ecologically grounded methods may provide a bridge between on-line and off-line cognitive resources[1] (see Wilson 2002 for a discussion of the concepts of on-line and off-line resources). Adding support to the notion of relationships among entities as key properties of creative practice, Di Scipio (2014) cites the work of anthropologist Tim Ingold (2011), "by insistingly speaking of 'networks', we end up experiencing the world in terms of a grid of 'interconnected points', although the lived experience of our multifaceted relationship to the world is [...] more like 'interwoven lines' [Ingold 2011: 63 and 70]. In other words, the 'lines' [how we move from one point to another, how we walk between end-points] are more central in our dwelling in the world: a metaphor of finely-threaded lines - such as the *meshwork* - should be preferred." Both metaphors, the *ecology* and the *meshwork* provide vessels for the manifestation of pattern formation processes through structural coupling. Both highlight the dynamic nature of interactions among entities that display properties which depend on the relationships with other entities.

3. Events, activities and ecologies

Computational applications have been at the centre of ecologically grounded creative practice since the initial proposals in 1997. Two early works ... *soretes de punta* [Keller 1998] and *touch'n'go / toco y me voy* [Keller 1999b] demonstrated that ecological modelling could serve as a support methodology for creative activity [Keller 1999a; Keller & Truax 1998]. The focus of these works was the notion that emergent properties can be elicited by the interaction of agents and objects within ecological niches. The adoption of a strict Gibsonian perspective implied a strong emphasis on the *multimodal event* as a creative working unit. Later artistic projects – *The trade / Oro por baratijas, The urban corridor / Corredor urbano* [Capasso et al. 1999; 2000], *IQ*[2] [Keller & Knox 2001], *Ukiuq Tulugaq (The Winter Raven)* [Burtner 2002] – unveiled the need to extend the theoretical tools to account for the higher temporal levels of the creative procedures. This trend was expressed in the following terms: "eco-composition emphasises the relationships between the compositional processes and the geographical, ethnographical and historical factors that inform the piece. From this perspective, the creative context becomes an integral part of the work. Furthermore, this dialogic relationship between

[1] On-line resources refer to the behavioural and cognitive support during the activity. Off-line resources are decoupled from the activity.

extra-musical sources and compositional methods sometimes creates acute contradictions within the piece, steering the compositional process toward new directions." [Keller & Capasso 2006: 58].

Building on top of the concepts formulated in [Keller & Capasso 2006 and Lockhart & Keller 2006], Nance (2007) expands the applications of the ecological framework to the realm of instrumental composition. "Damián Keller used [ecological psychology] to design software for composition, [Keller 2000: 55-60] and his work *touch'n'go*, is the first time ecological concepts have been used to compose a piece of (computer-based) composition. His approach was to build compositional models that parse time into event-dependent chunks… creating a system that is reconfigured whenever it finds new information. In other words, the temporal unit within which an event is observed, is (re)defined by its context." [Nance 2007: 15]. As Burtner (2005) and the Capasso+Keller+Tinajero Collective had done in their artistic projects between 2000 and 2006, Nance (2007: 16) underlines the importance of the multimodal qualities of the artistic experience. "I use ecological psychology's model of 'resonating sub-systems' in composition, as a special case of the organism-environment system in which, by awareness of the system's dynamics, and the system's parts, the system can be manipulated, not just reacting within it, but also by using the conceptual model of the system as a tool. [...] These compositions explore ways to guide (and be guided by) the outcome of 'emergent' percepts. These could all be realized as fully auditory, but will always be affected at some level, overtly or covertly, by non-auditory information, such as semantic, spectro-morphological, visual or kinaesthetic qualities." Nance suggests that eco-compositional activity encompasses three *loops*: the auditory loop, the studio loop and the research loop. Although a recursive *loop* could be interpreted as an iterative process that uses its output as part of its input, this is not explicitly formulated in Nance's text. The other usage of *loop* – as a repeated sequence of sounds – can be related to Schaeffer's (1977) *reduced listening* technique and the concept of abstract *sound objects*. Given that eco-compositional approaches propose exactly the opposite, i.e., that sound events are materially and socially situated entities, we will replace the term *loop* with *cycle of resource exchanges* with the exception of the cases that describe the algorithmic procedure.

The first cycle proposed by Nance is listening or auditory activity. Citing Whitehead (1922/2005: 14), auditory "fact is not the sum of factors; it is rather the concreteness [or embeddedness] of factors, and the concreteness of an inexhaustible relatedness among inexhaustible relata." Nance (2007: 19) argues that "what we hear relies on the combined perspectives of multiple senses. It is within this 'inexhaustible relata' that sounds are chosen, rebuilt and re-related to construct a musical work." Therefore, auditory activity is *embedded* in the context of everyday experiences that feature multimodal events as units of action-perception. These everyday resources can be incorporated into form-bearing procedures. For example, in *The Urban Corridor* [Capasso et al. 2000], the movements of the audience through the corridor-shaped installation space trigger sonic and visual events that bring the installation to life [Keller et al. 2002; Keller 2012; Pimenta et al. 2009]. The sculptural elements of the work serve to constrain the sonic affordances [Keller et al. 2010]. Thus, the aesthetic experience is not only shared by, it is actually *constructed with* the audience.

The second cycle of resource exchanges comprises the modus operandi of the composers within their working environments [Nance 2007: 20]. "The studio situation enhances the perceptual sensitivities of the composer by extending the sonic analysis through its analogue and digital system and external memory. [...] The studio composer

inhabits an environment with a special emphasis on sound interaction and manipulation. Source sounds are brought to the studio and enter the system via microphones and analogue to digital signal converters. The composer is also part of that system, and his experience of the sound enters the studio via the body. He has, in effect, recorded that experience, *been changed by it*, and participates in the system 'weighted' towards his experience with the sound." [Nance 2007: 20, my italics]. Like Burtner (2005) and Keller and Capasso (2006), Nance underlines the importance of situated action and the expanded notion of tool usage as a memory aid. What matters is not the environment [Schafer 1977], nor the isolated sound objects [Schaffer 1977], nor the abstract disembodied structures [Boulez 1986], what matters is the impact of the creative experience on the agents. As formulated in [Barreiro & Keller 2010; Keller et al. 2010; Keller et al. 2014b], the *creative activity* provides the opportunity to reenact previous experiences that have the potential to become aesthetic by-products. Keller and Capasso (2006: 57) postulated reenaction as a key characteristic of ecologically based creative processes. "The clash between the extra-musical context and the music-specific processes informs the creation of musical meaning and simultaneously reshapes the personal [sense]. Thus, an ever-changing history of meanings is established. Ecologically based works adopt reenaction as an integral part of the compositional process." In the multimedia installation *Vivir sin Después*, Capasso, Keller and Tinajero (2004) capture a moment before a storm while children play at a Napo River beach, in the Ecuadorian jungle. The art critic Robert C. Morgan (2004) describes the creative process used in this piece by alluding to the emergent qualities of the aesthetic experience: "Conventional time was reconfigured through the editing process to create an overlay of simultaneous activity. New cadences of images and sound were discovered as the artists worked with the density of form in relation to time and absence." Furthermore, the material aspects of the experience – in current eco-based creative practice terms, its *relational properties* [Keller et al. 2015] – served to enhance the mimetic characteristics of the visual, tactile and sonic elements. "As one enters into the projection space, there is sand beneath the viewer's feet – a sensation that disturbs the normative way we feel in the space of a museum. We are given a link to the boy whose small feet also stand in the sand. At this moment, we enter into the story […]." [Morgan 2004].

The third cycle of resource exchanges occurs at a slower rate than listening or dealing with sonic materials. "Whereas the monitor-computer-composer interaction is generally an analysis / re-synthesis [activity] that occurs at a duration between seconds and maybe days, the written analysis-composition [cycle] is occurring over a period of weeks and maybe years. it could, in fact, continue far beyond the composer's own research to be continued indefinitely." [Nance 2007: 20]. This third temporal level proposed by Nance – more properly defined as social interaction [Keller & Capasso 2006] – points to the need to consider the agents' behaviours as components of a larger system of relationships encompassing not only aesthetically oriented experiences but also everyday activities that impact the creative potential for future action. The dynamic depiction of relational properties proposed by Keller and Capasso (2000) together with the snapshot depiction of the structural resources laid out by Di Scipio (2014) suggest the concept of *behavioural ecologies* as units of study of ubiquitous musical phenomena. But what has been left out of the previous discussions of creative practice are the activities' unintended by-products. Let us take as example the emerging format of the laptop orchestra [Trueman 2007]. Laptop orchestras adopt a European nineteenth-century hierarchical approach to music making, using portable computers as instrumental components without changing the underlying social assumptions of the

orchestral model (see Small 1986 for a critical depiction of traditional orchestral practices[2]). Given the rapid replacement of computational devices, within the next few years most laptop computers will probably end in a dumpster, burying with them all the music produced for the laptop format. As Ruviaro (2012) suggested, laptop orchestras have been born to linger as historical curiosities, just like tape music, Wii and Kinect artworks. Alternatively, ubiquitous music research indicates that hardware repurposing strategies may provide viable paths to sustainable creative practices. Through the adoption of sustainable interaction design [Blevis 2007; Huang & Truong 2008], various prototypes have enhanced the available sonic resources [Flores et al. 2010; Lima et al. 2012; Vieira et al. 2012] without increasing the creative waste [Ferraz & Keller 2014]. The growing reliance on the browser as a music-making platform [Wyse & Subramanian 2013] highlights the need for design metaphors that provide support for long-term, scalable development. Lazzarini et al. (2014) have proposed *ubiquitous music systems* as metaphors to handle the material resources. Behavioural ecologies may complement this concept by taking into account the social aspects of musical activities.

4. Summary and prospective applications

In this paper I have provided an initial approach to ubimus behavioural ecologies from an ecologically grounded perspective. Behavioural ecologies for creative practice were defined as systems that shape and are shaped by human behaviour. Not withstanding the renewed interest in instrumental applications of ecologically grounded methods, the conceptual frameworks based on instrumental specificities may be too limiting for ubiquitous music practices. The metaphor of ubiquitous music ecosystems has been used to foster integrated and sustainable development of technological support for musical activities. Hardware repurposing has emerged as a viable strategy to reduce the proliferation of creative waste. Everyday technologies, such as the browser, may provide a suitable platform for the rapid implementation and assessment of new creativity support metaphors. But despite the fast turn over of material resources for sound making, little attention has been paid to the social and environmental implications of creative activity. Three cycles of resource exchanges – encompassing sonic resources, creative activities and the everyday activities that impact the creative potential for future action – were considered. Co-creation, relational properties and behaviours emerge as relevant aspects of ecologically grounded creative practice. These elements can be encompassed by the metaphors of the meshwork or the ecology, both stressing the dynamic relationships among entities and providing a background for the discussion of structural coupling, pattern formation and emergent properties.

Summing up, behavioural ecologies both require and produce human behaviours. When placed in the context of creative practice, behavioural ecologies afford the deployment of resources for creative activity. Some ecologies exhibit creative behaviour as by-products of the interactions among agents and material resources. These by-products can become resources for future creative actions, they can be experienced as creative products or they can be discarded as creative waste. Creative by-products can be employed to assess the sustainability of the creative ecology. An important class of material resources for ubiquitous musical activity is the available technological infrastructure, or the ecosystem of technological resources. This infrastructure both constrains and affords creative outcomes; hence, behavioural ecologies for ubiquitous

[2] "The close association between the industrial mode of production and the symphonic orchestra can be seen in societies that have recently been converted to industrialism (the industrial philosophy can of course be seen as overriding the ideological differences between capitalism, socialism, communism and most other isms); the formation of professional symphony orchestras and the appearance on the scene of a number of Wunderkind performers is often the first indication that such a conversion has taken place and has become [internalized]." (Small 1986).

music making encompass tools, behaviours and by-products that afford and constrain human creative behaviour.

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