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Discerning Relational Data in Breath Patterns. Gilbert Simondon's Philosophy in the Context of Sequence Transduction

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Abstract

This article discusses Gilbert Simondon's philosophies of the technical object, information, and individuation to frame the potential inherent in a practical application of his notions of *intensity*, *amplification,* and *transduction* of relational processes, which have been largely neglected in the traditions of substantialist and hylomorphic thought. Specifically, the study introduces a method to discern relational information by amplifying audible breath patterns of a collective via a wearable digital stethoscope (WDS). The non-lexical modality of the breath grants insights into non-verbal phases of communication during which multiple points of view may exist simultaneously. These points of view can be understood as a subject's sense of orientation within phases prior to signification, i.e., before *affect* becomes a specific *emotion* and before *perception* becomes a concrete *action*—using the terms as they are defined by Simondon. Bodily movement is audible within the breath and can be further transcribed into preliminary signs with the help of a sequence transduction machine learning (ML) model. Discerning semiosis within audible breath patterns exemplifies a logic of computation which is not concerned with quantitative and qualitative information but, instead, computes intense data to grasp relational dynamics.

Keywords

Intensity; Breath patterns; Sequence transduction; Digital wearable stethoscope; Transindividual, Gilbert Simondon.

Introduction

> "[T]he technical object is the form, the material crystallization of an operational schema and of a thought that has resolved a problem. In order for this form to be understood it is necessary that there be analogous forms in the subject: information is not an absolute advent, but the signification resulting from a relation of forms, one extrinsic and the other intrinsic with respect to the subject." (Simondon, 2017, 253)

Technical objects are relational objects. In inter-human relations they create *transindividual* relations which French philosopher Gilbert Simondon describes as created by the invention of the technical object as an intermediary (Simondon, 2017, 253). He further describes transindividuality as a process which creates information not yet matter or form but the transition or in his words, the *transduction* which constitutes processes (Rodriguez and Blanco, 2016, 42). This study utilizes Simondon's theory of information both hermeneutically as well as operationally by outlining tactics to discern relational information in audible breathing with the help of wearable digital stethoscopes (WDS) and a machine learning (ML) model. Simondon's theory provides the language to describe how the audible breath contains relational and *intense* information that is organized neither by Gestalt theory's structural qualities or "good form," nor by information theory's "quantity of pure information" (Simondon 2021, 267). Intensity of information, as described by Simondon, is, instead, organized around a context unique to each subject due to the degree of relatable information within a specific situation (271).

Intensity of information is, thus, a singular modality and perceiving as well as analyzing it calls for a methodology which retains singularities and context without classifying them into categories. This article adopts Simondon's vocabulary to establish a new materialist methodology as an operational alternative to common dualist mechanics of computation. It reimagines the purpose of datasets in general and reorients artificially intelligent agents towards the analysis of intense and unannotated data. In order to capture intense uncategorized data, the study first lays out how the breath is identified as a modality which expresses the intensity and relationality of living organisms. It then discusses how the WDS traces these intense

relations by capturing the breath and rendering the ephemeral modality of intensity a subject of further analysis. Finally, the study outlines a sequence transduction ML model capable of analyzing this transindividual data within the breath. This ML model computes transindividual data as it is described by Simondon's theories of the technical object, information, and individuation. This mode of computation allows one to a) discern patterns of relation in real time and, thus, predict future movements and b) reflect on these patterns of captured intensity by tracing the semiosis indicated by their recurrence. Due to its ability to train on singular and constantly evolving data, this model is not deployed to find preconceived categories but rather to detect recurring patterns, in other words, semiotic elements that evolve within the joint breathing of a particular dyad. Targeting the breath as transindividual data takes into consideration the constant influence the environment has on subjects as they are individuating. These changes within the data are frequently ignored by the logic of classificatory algorithms.

Breath as a Singular and Multi-perspectival Modality

In a Simondonian reading of the term *intensity* (2021, 267), a subject's subtle physical reactions to its environment contain intense information that cannot be quantified but only perceived in its idiosyncratic context. The audible breath is tightly linked to the body's reactions and its kinaesthetic awareness. It is susceptible to nuances of the body's expressions since muscles move with regards to the oxygen they receive. Prelexical, expressive, but rarely concerned with signification, breathing functions as an *intentional cue* (Corness, 2013, iv). It informs what cultural theorist Erin Manning has termed *preaccelerations,* or the process and virtual force of bodily movement taking form (Manning, 2009, 6). In other words, discerning patterns of breathing reveals how a body is about to move, and discerning breath patterns of bodies in relation to one another reveals information about how they are moved by each other.

Interactions are commonly described as occurring between individuals defined through either a substantialist or hylomorphic viewpoint. These conceive living beings either as part of a unity or as an amalgamation of form and matter (Crary and Kwinter, 1992, 297). Simondon counters both monism and bipolarity by focusing on an

ontogenesis which accounts for the fact that living organisms are constantly *individuating*, i.e., developing, growing, aging, decaying, and only able to do so by being entwined with their environment, or their *milieu* (Simondon, 2021, 7). He argues that this active genesis is not accounted for in monism or pluralism, which equally rely on an already individuated substance and "put themselves in the impossible situation of rediscovering an effective genesis" (304).

As a result of the effective genesis in his theory of individuation, Simondon describes perception and communication as processes which are neither fully quantifiable nor fully qualifiable. He, instead, turns to the notion of intensity which renders perception a process that does not have a finite number of solutions but retains room for multiple solutions simultaneously (271). These simultaneous possible solutions are constantly present when organisms' encounters are "grasped as transductive and not as classificatory" (Simondon, 2021, 359). Transductive encounters cannot be measured or secured by qualitative or quantitative means; they are contextualized through their *intensity of information* (269). Graspable neither as quality nor as quantity, intensity is a slippery feature to analyze. To track intensity, one needs a modality which traces, however, does not signify and repress intensity by merely rendering it into yet another quality or quantity.

In this study, the focus lies on the non-lexical intensity of breathing, which reflects the movements performed by bodies. The modality of the breath traces their encounters in a non-intrusive manner as it remains non-lexical even when captured with the WDS. The non-verbal expressions of bodies, evident in their breaths, provide a record of the reciprocal and simultaneous exchange which takes place constantly amongst bodies and their environment. This form of casual nonverbal communication is not organized around questions and answers, or more generally, around the notion of turn taking as dictated by the structure of verbal communication. Instead, organisms exchange intense nonverbal information at a fast pace and make and adjust their propositions simultaneously and constantly (Barsalou, 2003; Barrett, 2017; Bateson, 1977). A verbal proposition to cooperate with another is, for instance, spoken by a body, which cannot help but produce nuanced and constantly adjusting expressions.

Whenever these adjustments are mutually recognized and acted on, this formation of movement potentially actualizes joint gestures. In this case, the idea or movement can no longer be traced back to one source and necessarily contains more than one perspective. This happens frequently during, for example, the enactment of both scored and improvised dance and music (Foster, 2019; Manning, 2007; Sawyer, 2003), as well as in everyday encounters. The multiplicity of perspectives negotiated non-verbally are neither finite nor categorized and thus remain receptive to continuous adjustments. Cultural theorist Erin Manning calls this "movement's capacity for invention" (2009, 19) and explains that subjects can experience a symbiosis when they perceive each other as both active and passive and are no longer aware whether they are following or initiating their shared impulses (Manning, 2007, 101). In this context, the mechanics behind the process of symbiotic individuation are applied to computation and function as an alternative to the common comparative model. Simondon's framing of intensities provides the language to describe the breath as a multi-perspectival modality that can trace this symbiotic individuation because it is a necessarily relational feature–at once impression and expression–and amounts to an operation which does not settle on one particular meaning or form.

Intensity

Gilbert Simondon (1924-1989), Philosophies of Difference, and New Materialism

Simondon worked towards bridging engineering and science through philosophy while focusing on operations rather than on structures and on relations rather than on identities (Rodriguez and Blanco, 2016, 34). The notion of intensity is central to his theory of information, his theory of the technical object, and theory of individuation. He applies intensity to bypass qualitative and quantitative signification in order to access and discuss the ephemeral.

A student of phenomenologist Maurice Merleau-Ponty, Simondon is considered a precursor to poststructuralism, specifically to philosophies of difference and new materialism. He had great influence on philosopher Gilles Deleuze and his

elaborations on difference as intensity's form, on virtuality, and on his refusal to rely on a binary logic of negation (Deleuze, 2001, 52). Australian philosopher Elizabeth Grosz (2019) contextualizes Simondon's influence on Deleuze, herself, and feminist new materialism more generally, by pointing out that it is in part Simondon's theory which provided the language for Deleuze's ethics of the event (171). She writes: "[i]nstead of opposition, Simondon speaks of disparation, the productive tension between two closely related but incompatible orders; instead of identity, or individuality, he speaks of individuations; instead of forces, he speaks of energetic potentials; and instead of the negative, he speaks of creation" (171). This language, to her, suggests an ethics around the study of ontogenesis instead of an ontology (170); it creates a wide and further dispersed notion of agency that is experienced through the entangled becoming of subject and milieu. Grosz concretizes the cultural relevance of Simondon's abandonment of hylomorphism by arguing that his ethics displaces the hylomorphic model and along with it dichotomies established since Aristotle if not earlier, such as, on the one hand, matter connoted as being passive and feminine, and on the other hand, form connoted as being active and masculine (171). Philosopher and political theorist Jane Bennet (2010) similarly points to the neglect of the androcentric and discriminatory hylomorphic model by both Simondon and Deleuze via their notions of intensity. She elaborates on Deleuze and Felix Guattari's notion of material vitalism, which, counter to the hylomorphic model, regards matter as lively in itself. Bennett traces Deleuze and Guattari's notions of "intensity," "virtuality," "matter-energy," or "pure potential" that counter the notion of hylomorphism back to Simondon's prior, however, publicly less recognized efforts in achieving exactly this via the concept of intensity (55, 56). Feminist new materialism has brought forward a considerable amount of research which rests upon and discusses Simondon's concepts of individuation and information and his critique of dualist thought, for instance, his critique of Norbert Wiener's concept of information as analyzed by Andrea Bardin (2021, 9), or Émilie Filion-Donato's (2021) recontextualization of the notion of individuation, power, and curiosity within the context of psychoanalysis and materialism, via the work of Ernst Schachtel, Karen Barad, Donna Haraway, and Evelyn Fox Keller. Simondon's reach beyond the dichotomy of form and matter has created an ethics and vocabulary which remains

operational and concrete despite his discussion of the ephemeral notions of intensity, relationality, and communication.

Incisiveness of Perception

In order to describe the ephemeral dimensions of communication which can be revealed through the breath, it is necessary to adopt a language which accounts for a dimension that cannot be described by referring to qualitative or quantitative measures. In his effort to frame information, Simondon introduces the notion of *thresholds of intensity* as points of reference and as an alternative to the references of quality and quantity (2021, 264). He uses the example of a photograph to explain that in order to define the reality of information neither information theory nor Gestalt theory provide adequate solutions. While information theory defines information via the quantity of available units by which information can be stored and represented, i.e., a coarse or fine emulsion of a photograph (265), Gestalt theory argues that "good form", in other words, an image rich in information, is discerned by structural quality. This structural quality, however, amounts to the number of signals required to transmit a degree of complication and does not offer a logic different from that of quantification (267). Neither of these approaches accounts for the relational dimension of perception in the sense that humans do not perceive objects as individual by grasping an "inexhaustible reality, like matter" but, instead, by perceiving "the reality of certain thresholds of intensity and of quality maintained by objects" (264). When increasing the contrast of a photograph, for instance, objects might be perceived as clearer while information theory would claim that information is lost. Similarly, in the context of this study, information is "lost" while rendering the WDS recordings more *intense* by considering only the frequencies within the range of 100-1000 Hertz (Hz). This selection foregrounds the breath sounds and renders them more expressive by eliminating background noise, such as heartbeats, in the range below 100 Hz, as illustrated in Figure 1.

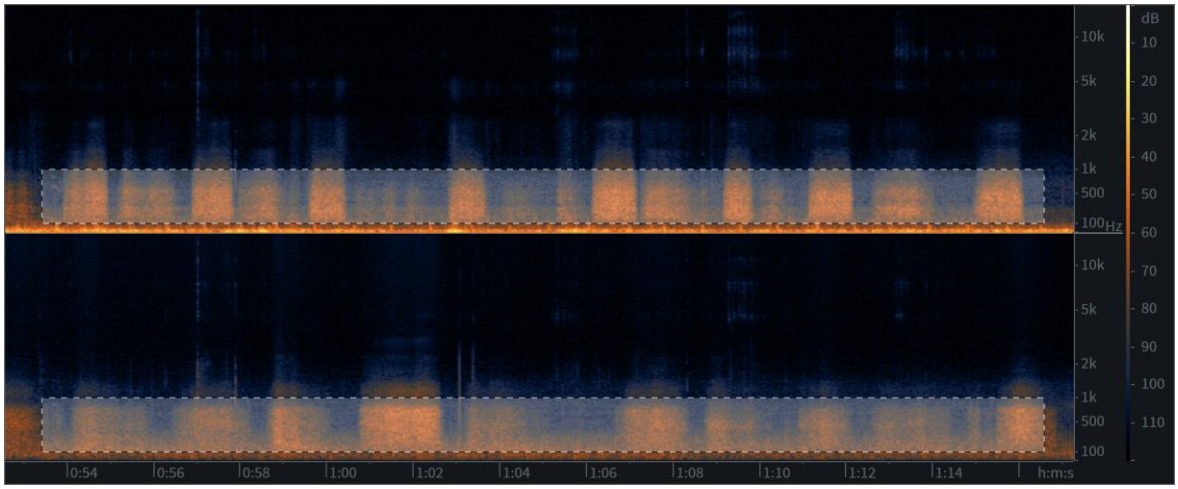

Fig. 1. Simultaneous WDS recordings of the breaths of two subjects. The selection of frequencies between 100 and 1000 Hz foregrounds the breath's *expressivity*. An audio sample can be found here: https://vimeo.com/672922743 (accessed on 17.02.2022)

Simondon explains that a subject's perception is dependent on this notion of expressivity (267). An image might thus be expressive and hold information due to the fact that it is slightly out of focus or that it has a shallow depth of field. "A geometrical rigor of a contour," on the other hand, might carry less information and amount to a less incisive[1] perception (268) because the content is less unique to each subject due to the lesser degree of relatable information within a specific situation (271). He explains:

> "Certain tonalities, certain colors, and certain timbres can be part of an intense perception without even constituting a good form. It thus seems necessary to distinguish between the clarity and the [incisiveness][2] of a perception; [incisiveness][3] is veritably linked to the dynamic nature of the perceptive field; it is not just a consequence of the form alone, but also and more importantly a consequence of the range of the solution it constitutes for the vital problematic." (271)

[1] In the only translation of Simondon's *Individuation in Light of Notions of Form and Information* to date, the French word *prégnante* was translated with the English term pregnant. In French, the word *prégnance* translates to *incisiveness*, which, despite of its etymology (Latin *praegnans*), is not used to describe the biological state of a pregnancy or being pregnant. In French it is not the word *prégnante* that describes a pregnant body, instead the word *enceinte* is used. What in the English translation might seem like problematic neutral use of language by the author, is instead an inaccuracy in the translation by Taylor Adkins. For this reason, I will exchange the translated terms "pregnancy" and "pregnant" with the term "incisiveness" and "incisive" in this article.
[2] My annotation, see footnote one.
[3] My annotation, see footnote one.

The vital problematic describes the residual nature of life for the individuating subject that due to its constant development cannot take on signification and constantly remains exposed to a multitude of solutions to the problem of life (237). Intensity, or the incisiveness of perception, thus remains ephemeral and may be "confused" rather than clear and "will be more [incisive][4] in proportion to how dynamic the prior state of incompatibility is" (271). Simondon gives the examples of intense desire, fear, or the perception of a smell which may each be intense, however, are often perceived as rather unclear or confused as they do "not include solidly structured elements" (271). Nonetheless, intensity functions as a means of orientation by adhering to objects as temporal stabilizations of a milieu in flux (270).

Incisiveness of Concepts and the Breath

Equally in flux, breathing can be described as a metastable modality which traces situations through its perpetual fluctuation and adaptation. This study charts breath as a modality which is situated in the center between perception and signification. When Simondon notes that the "genesis" of concepts results from a process of "ongoing reactivation" similar to that of forming perceptive units, he remarks that there is no clear separation between that which is perceived and the perceiver, but rather, an "inter-perceptive" tension which relates the subject to the world and to itself. The temporal dimension, too, is not divisible into that which was there before and that which is happening while a subject perceives its environment. Instead, Simondon describes a metastable situation in which "a priori forms do not rigorously preexist perceptions" (271).

Concepts, mediations, and information are thus discovered from the center between a metastable form and an equally metastable perception as neither of these terms preexist one another. The pre-lexical while informative nature of breathing is situated in this center of intense mediation because it traces the dynamic tension of the subject and its milieu while the breathing subject is in the process of perceiving. Breath is tracing the simultaneous transductions of perception towards signification

[4] My annotation, see footnote one.

and signification towards perception. This process is necessarily relational and a constructive potential innate to the individuating subject and its environment, in other words, "relation does not spring forth between two terms that would already be individuals; relation is an aspect of the internal resonance of a system of individuation; it belongs to a system state" (8). Investigating the audible breath as an internal resonance of a system operates both hic et nunc and at the level of concepts when considering the WDS recordings as traces of semiosis. The WDS enables this tracing of specifically the auditory qualities of the breath with their perceptual attributes such as timbre, i.e., auditory brightness, roughness, attack quality, and inharmonicity (Siedenburg et al., 2019, 24). These are characteristics which contribute to the incisiveness of perception due to the degree of intensity they invoke. Intensity of information, such as timbre is a means by which subjects orient themselves within vital dynamism and, in the words of Simondon, "[e]very received signal in this sense possesses a possible coefficient of intensity due to which we constantly correct our situation relative to the world we inhabit" (269). To summarize, there is intensity in any perceived signal and intensity contributes to the incisiveness of perception while it is not necessarily a clear signal. Clear signals, such as concepts and information, arise from an interpretative and necessarily relational tension. This relational tension is pre-individual, and it contributes to the internal resonance of a system. Within a subject there are aspects of this internal resonance that can be discerned by tracing its audible breathing.

In order to trace a subject's breathing a technical object needs to transform the sound of the breath into electrical energy. As a technical object traditionally used for auscultation a stethoscope renders internal sounds of the body more perceptible to the human ear. The membrane functions as a resonator which, when placed against the skin, amplifies sounds coming from inside of the body. My WDS consists of a lavalier microphone which is attached to a stethoscope head via a short piece of stethoscope tubing; it allows to record clear breathing sounds, and specifically sounds of the breath of bodies in motion. It provides a more feasible and lag-less alternative

to current models on the market,[5] and it can be constructed from off-the-shelf components. The signals presented in this study have been recorded at the throat while the stethoscope head was secured around the neck with a strap. Because of the relatively small diameter of the neck, a stethoscope head with a small diameter (infant size) creates a clearer signal as the membrane's surface touches the skin more evenly. The images below show the assembled WDS (Fig. 2).

Fig. 2. WDS comprised of a stethoscope head and a short piece of stethoscope tubing which connects the stethoscope head and a lavalier microphone inserted at either side of the tube. 3.5mm TRS audio jack connection (right); lightning connector (left).

Transindividual Breath

> "The technical object taken according to its essence, which is to say the technical object insofar as it has been invented, thought and willed, and taken up [*assume*] by a human subject, becomes the medium [*le support*] and symbol of this relationship, which we would like to name *transindividual*. … An inter-human relation that is the model of *transindividuality* is thus created through the intermediary of the technical object" (Simondon, 2017, 252-253)

[5] This WDS is reliable and more feasible (≈$30.00) than the two devices currently on the market: *Thinklabs One digital stethoscope* ($499.00, professional medical equipment), and the *Stemoscope* ($79.99), which lags due to its bluetooth connection.

The Collective

The transindividual relationship relies not only on the invention of the technical object at its center but Simondon furthermore specifies that the "weight [*charge*] of pre-individual reality" with its "virtualities and potentials" (253) is part of this connection. The *pre-individual* is tied to the perpetually changing formations within the process of individuation; it describes not a fixed individual but, instead, the subject, which is defined by Simondon as in constant development and both pre-individual and individuating (Simondon, 2021, 348). The notions of the pre-individual and individuation account for relationships which render situations metastable and "turn them into problems with multiple solutions" (262). These solutions can only be accessed through the collective as the only way for the subject to coincide with both its pre-individual and individuated facets, thus with itself, is through the collective as a reference.

Simondon explains the necessary reciprocity of the collective and the subject by defining emotion as the signification of affectivity while affectivity is the foundation of emotion, and action as the signification of perception while perception is the foundation of action (279). Both affectivity and perception bring to the subject "something from the outside" (280) through the other by means of the individuation of the collective, which constitutes the environment. An exchange between subjects is necessary in order to concretize perception and affectivity towards potential solutions pursued via action and felt as emotional "states" and for the subject to become aware of affect and perception. This notion of awareness of affect and perception, however, cannot be fixed within a semantic or even semiotic solution. At that point, it could be described as an emotion or an action, and it would no longer be intense. Breathing is one of the few activities that simultaneously engages the subject consciously and subconsciously. Due to its non-lexical disposition and consistent fluctuation, the action of breathing is an activity present throughout the formation of affect, as well as emotion, and throughout perceiving, as well as acting. A focus on the subject's metastable exchange of gases with the environment and the collective, indeed, further blurs these boundaries. The notion of the subject is porous. By tracing the tangible im- and expressions of a collective via their breaths, the intangibles of

affect and perception become, to some extent, traceable. Tracing commonly applies to quantitative and qualitative representation and not to intense processes. Here, the intensity of affect and perception can be recorded within the non-lexical modality of the breath while emotion and action equally leave traces within the breath and–more concretely–within language. The Canadian philosopher Brian Massumi (1995) specifies this connection between language and emotion; he calls an emotion a "socio-linguistic fixing" (85), a personal and qualified intensity which is *de facto* no longer in flux, affective, or intense. As mentioned earlier, the modality of the breath escapes the common mechanics of verbal turn-taking or, in Massumi's words, the "narrativizable action-reaction circuits" (85) of a semantic order. He speaks of a paradoxical suspension of affect and intensity which exists simultaneously in flux and as fixed states and solutions while he defines emotions as concrete units which lack intensity due to their semantic qualities (86). Within the breath patterns which emerge in a collective, the paradoxically active while simultaneously passive potential of intensity and affect is retained.

Affect and perception are active only in this intense state of suspension wherein subjects collectively render some aspects of this suspension emotion and action. It is energetically potent because it is a collaborative moment during which more than one perspective is in the process of forming. Simondon (2021) parallels this process to that of solving a problem when he writes: "the position of the problem in a certain sense bears the possible solution as a tension toward a signification that incorporates the data of the problem, albeit without the prior formation of the effective lines of the solution, which would only appear through the real becoming of resolutive invention" (367). Resolutions are moments which shed the potential of the multiplicity from which they are derived. They are simplistic enough to function well within the teleological order which tends to dominate encounters on the surface. Working with pre-individual affective states takes a paradigmatic shift which designates resolutions as partially counterproductive and, instead, sets the focus on relations.

Breathing as Relational Amplification

Organizing knowledge according to the simultaneity inherent to a relational logic and foreign to a logic of resolutions can be traced within breathing. Breathing traces and thus reveals the process during which perception and affectivity are enacted as a way of knowing before they are transduced into concrete states, i.e., before affectivity becomes a specific emotion and before perception becomes a specific action. A multiplicity of possible solutions, in other words, relational knowledge, is thus retained as long as the particular situation is not yet signified but nevertheless *real*. Relational processes constitute the *real* in Simondon's theory of individuation. Reality is not behaving according to substances which define certain terms, instead, substances are temporal states in motion as the relations they are composed of are constantly forming anew (5). Relations are furthermore an epistemological reality or a "*constitutive, energetic and structural condition"* (76) which is not dependent on form or matter.

In contrast to teleological thinking, this form of relational knowledge enacts multiple real points of view simultaneously. Equally in a state other than that of a clear signification, the audible breath of a collective reveals a multiplicity of solutions within a situation because it is directly involved in any movement the bodies do or do not make. These movements can be traced through the breath and via the WDS. Accessing this collective way of knowing with the WDS and further discerning patterns in the breathing of multiple subjects with a sequence transduction ML model, as described in the following sections, is analyzing a form of *amplification* (396), which Simondon defines as an act which does not have a resolutive limit and thus has the capacity to go beyond itself (378) and beyond one particular point of view. This amplification with its simultaneous viewpoints is depicted in the following spectrograms which show WDS recordings of the breaths of a dyad involved in a number of different activities (Fig. 3-7).

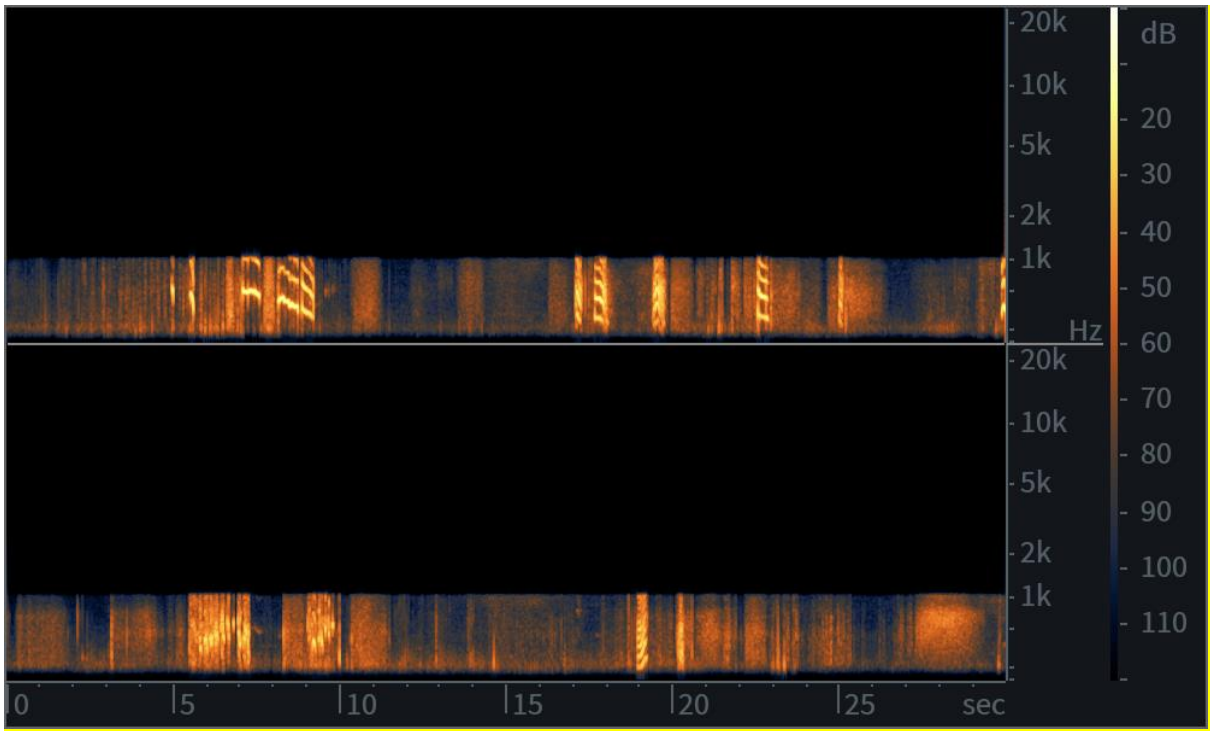

Fig. 3. WDS breath recordings of two subjects in conversation.

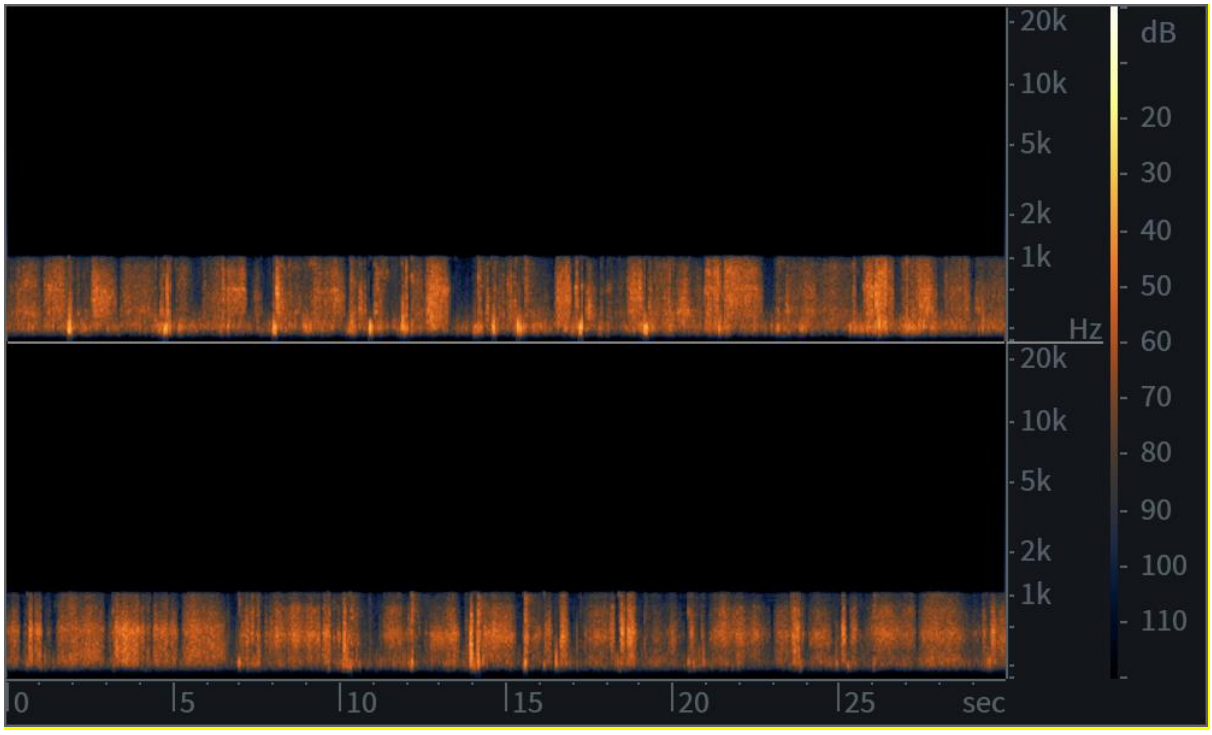

Fig. 4. WDS breath recordings of two subjects throwing back and forth a soccer ball.

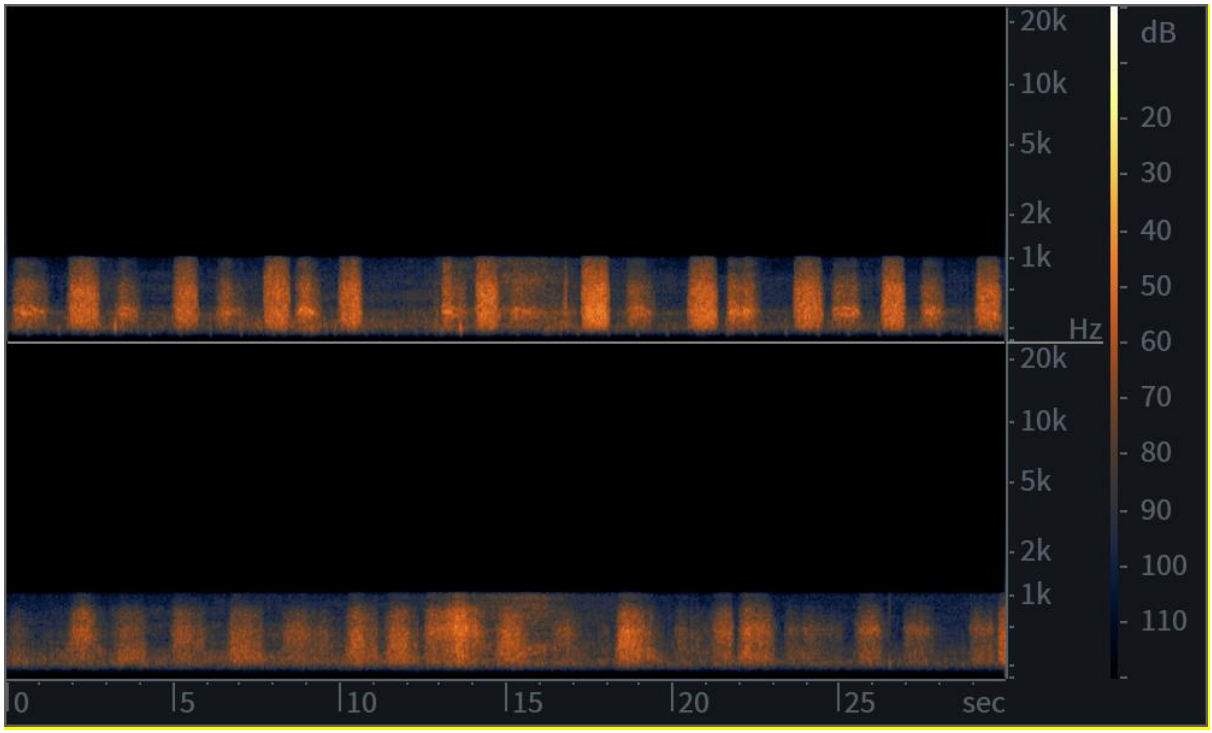

Fig. 5. WDS breath recordings of two subjects jointly solving a puzzle.

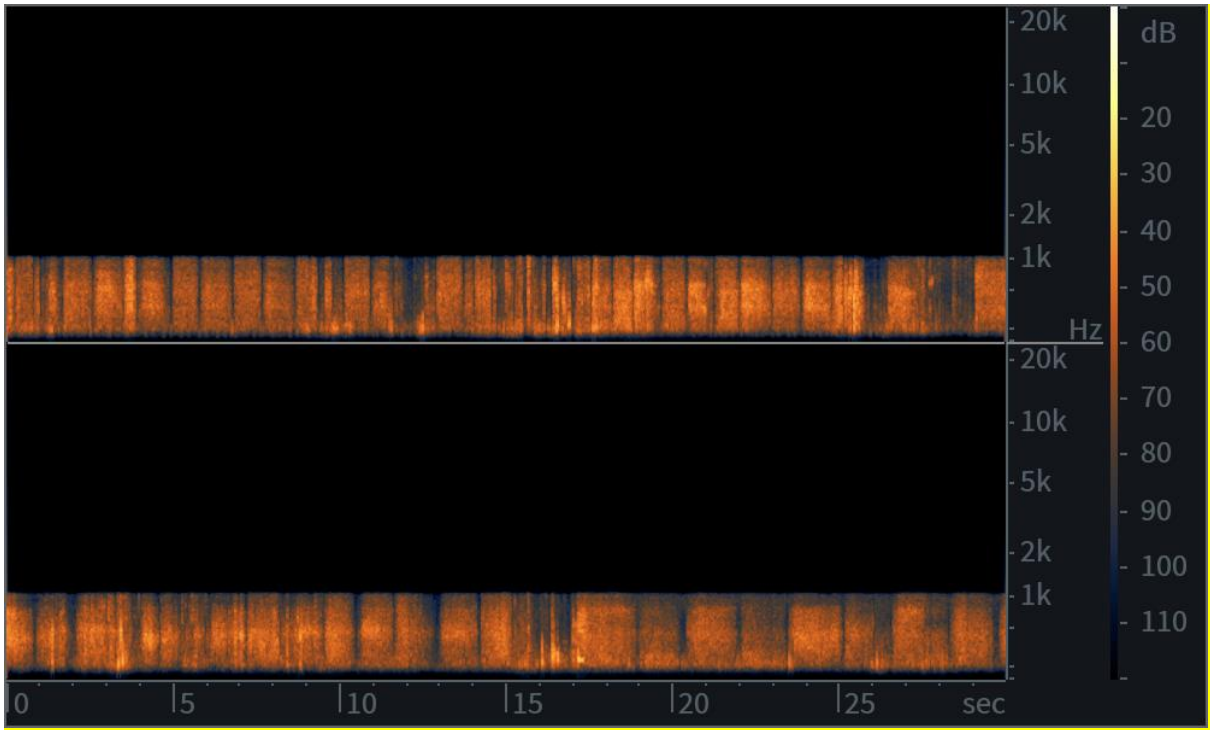

Fig. 6. WDS breath recordings of two subjects, one on top of a barrier (below) helping the other (above) to jump onto the barrier (jump at sec 16-17).

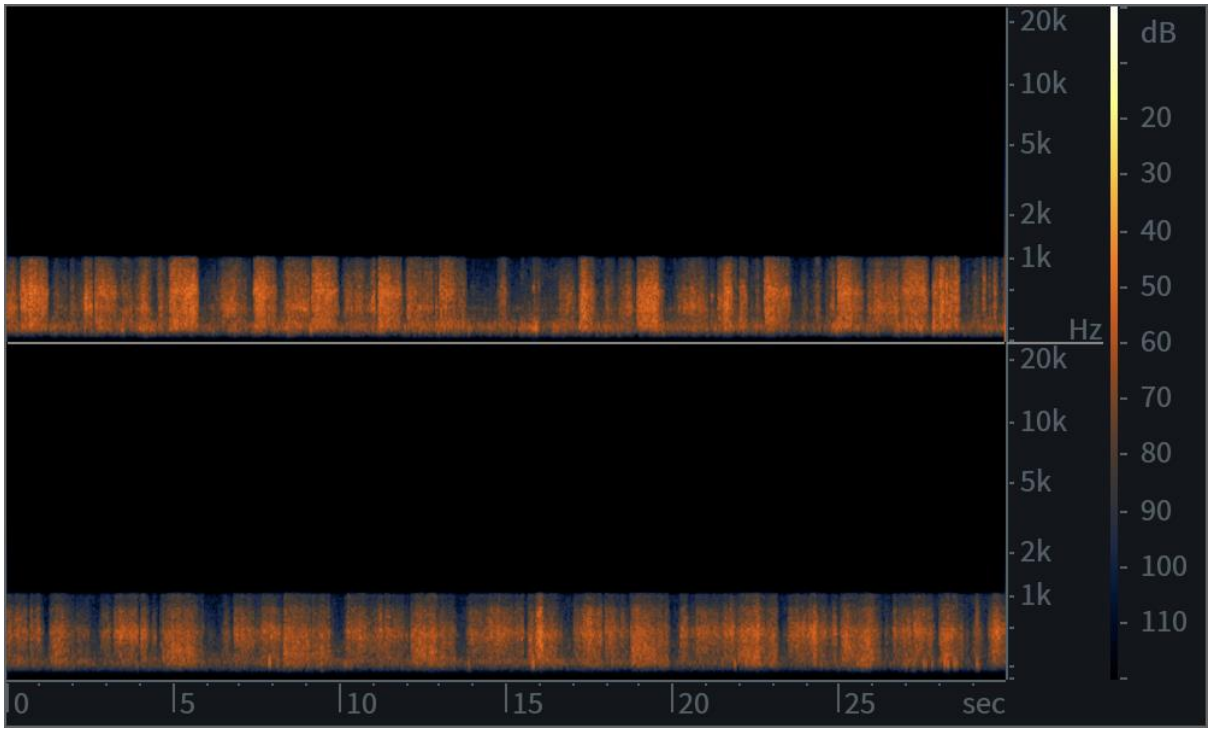

Fig. 7. WDS breath recordings of two subjects dancing Foxtrot.

Transduction

Transduced Data

The breath patterns above illustrate that mental and physical activities are impossible to separate and that subjects are entwined with each other and their environment, for instance, the ground due to the force of gravity. Within the breath there are traces of impulses which belong to what Simondon refers to as the *perceptive relation, the active relation,* and *the affective relation* of consciousness (272). As described earlier, these relations are of the subject and the collective and exist within the suspension of relational transduction. Simondon explains that "[a]t the level of affectivity and emotivity, the relation of causality and the relation of finality are not opposed: every affective-emotive movement is simultaneously judgment and preformed action; it is really bipolar in its unity" (273). Because Simondon views transduction as more fundamental than causality and finality (272) his theory introduces a simultaneous multipolarity.

The three-dimensionality of the spectrograms show these simultaneous relations which, without this transformation into the visual realm, would remain merely on a temporal plane. They represent three dimensions of the sound signals. The x-axis

represents time (in sec) and the y-axis represents frequency (Hz). The various colors represent the amplitudes of particular frequencies at particular times (dB). Through these dimensions the relational processes can be reflected on in a non-linear fashion. Meditating this multidimensional and non-lexical trace of collective breathing might be somewhat representative of the way in which Simondon describes a subject's realization of its own progressive individuation through "successive leaps" (272). In this context, Simondon points out critically Gestalt theory's privileging of the perceptive relation over the active and affective relation. He further claims that this one-dimensionality is closely linked to the temporal plane that amounts to an external logic which does not account for the subject's own temporality (of "successive leaps"). These successive leaps may be traceable more easily in a nonlinear manner through the visualization of frequency and amplitude which reveal patterns of expressions within the breath. These expressions range from pauses and subtle noises to more pronounced activations, and they are in direct correlation with the breath patters of other subjects in proximity.

The ability to trace and record this correlation of multiple subjects' breath patterns while they are in motion via the WDS grants an investigation of subject relations within an environment outside of the laboratory. It further permits to investigate affectively charged intense moments which involve multiple points of view, independent of signification. As I have mentioned elsewhere, these multiple viewpoints can be represented by overlaying the breath signals of various subjects into a monophonic signal which quite literally combines these points of view as illustrated below (Fig. 8).

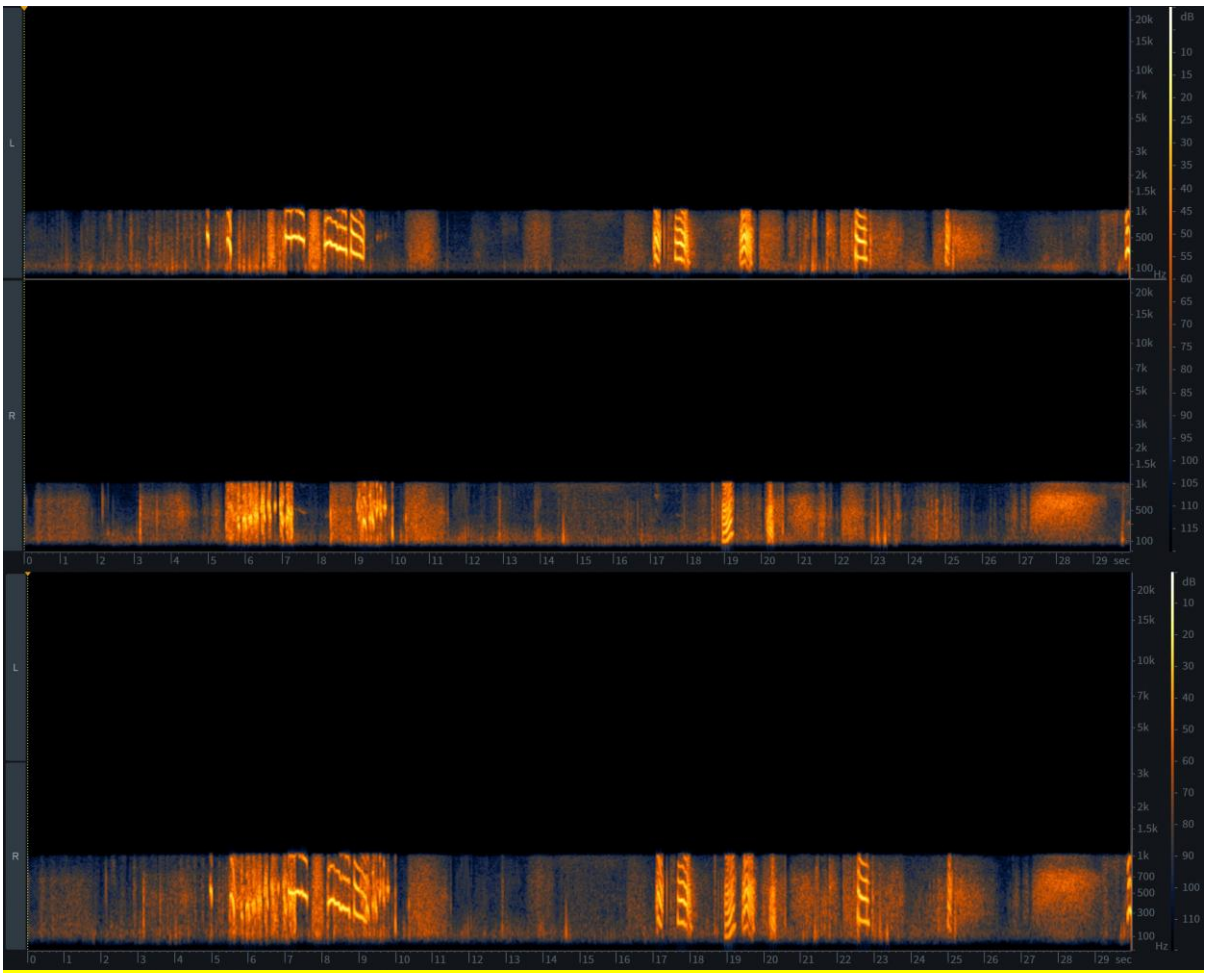

Fig. 8. WDS breath recordings of two subjects in conversation (above channels) overlayed into one monophonic signal (bottom channel).

The monophonic signal (bottom channel) can be read by an ML model as data of the simultaneous viewpoints of a collective and can be compared to different moments in time of the same signal. Since the data of specific dyads is singular and not transferable to other collectives, the already recorded audio signals themselves function as the training data for each particular dyad's successive breath signals. In this case, the oftentimes problematic lack of nuance in the categorized training data of artificially intelligent agents and specifically ML models, is countered by the assertion that data indeed needs to be singular in order to better avoid the inaccuracy inherent in any categorization. This is not an argument for a virtualization of digital computation, computation remains discreet, while the data, on the other hand, is decidedly singular in this experiment. In accordance with cultural theorist Beatrice Fazi (2019), who relies on Simondon's terminology in her effort to find "another

indeterminacy" (23) within computation, this article mobilizes Simondon's concepts of information, individuation, and transduction to offer a critique of representationalism while acknowledging computation's formalist condition.

Sequence Transduction

> "Transduction, then, is not only a path taken by the mind, it is also an intuition, since it allows a structure to appear in a domain of problematics yielding a solution to the problems at hand. In the sense contrary to deduction, however, transduction does not seek elsewhere a principle to resolve the problem at hand; rather, it derives the resolving structure from the tensions themselves" (Crary and Kwinter, 1992, 314-315)

Applying the logic of transduction to an ML model which discerns patterns in the breaths of a collective results in a model which relates the particular to the particular. Counter to both in- and deduction, transduction is a form of transposition which derives inferences directly from a set of examples. Transduction proves useful when training data is limited (Vapnik, 1995, 169). The method is appropriate in this case since regardless of how expansive the training dataset may be, it will remain diverse because affective thus singular data is purposefully included and not categorized, as laid out above. Singular data is challenging to analyze since it is unique. By employing a model which analyses sequences, this singular data is put into context because patterns which are unique to a particular dyad might reappear in similar forms at different times throughout their encounters. The model thereby organizes patterns of breath according to the context in which they appear. When it discerns patterns within a spectrogram like the monophonic overlay of the breaths of multiple subjects above, it analyses patterns of a relation which contain multiple viewpoints as opposed to comparing them. These multiple viewpoints are retained because transduction does not act according to a logic of form, which would result in matching the image of, for instance, a face to the images of faces the model has previously been trained on. A categorization would not attend to the potential of these multiple viewpoints but simply sum the input up to match a preconceived notion of form. Instead, transduction

is acting according to the logic of information which is constantly individuating and readjusting (Crary and Kwinter, 1992, 315).

As a model which organizes around sequences of information, *sequence transduction* does not classify in order to compare fixed formations but, instead, analyses a duration of time. As the sequences change, the inferences adapt simultaneously, and patterns are continuously reevaluated. More common examples of such continuous evaluations performed by sequence transduction models are transformations, such as music transcription or language translation, which may involve both speech and text (Purwins et al., 2019, 207). Usually, this is a transduction from one signification to another. Since, however, Simondon's theory of individuation rests on the notion of information rather than form, it describes a form of semiosis which allows for another stage of amplification, i.e., moments which continue to contain multiple viewpoints despite a completed individuation. He writes:

> "In its separate, recorded, indirectly transmitted aspects, information also expresses a completed individuation and the resurgence of this completion that can extend into other stages of amplification: information is never after individuation alone, for if it expresses a completed individuation, it does so with respect to another individuation that is capable of being completed" (Simondon, 2021, 372)

With reference to the breath, these individuations capable of completion which point to further such individuations, are at different stages of amplification in the sense that they refer to recorded, and thus to a certain extent, fixed elements. Recorded collective breath, however, traces the not yet signified phases of encounters and the way in which they emerge towards signification. The impulses which are present before the collective turns perception into action and affect into emotion are recorded just as well as solutions which signify concrete actions and emotions. Within the WDS recordings they are not of a different order but equally become part of a semiotics performed by both ML model and human interpreter.

Discerning the different stability of these impulses, which are stable together only by means of the recording, is a transduction at work. Some of the impulses will not become solutions but contribute to their formation. The sequence transduction ML

model help to recognize and organize these impulses, and even though this transduction is not as concrete as translating one language to another, it, nevertheless, can be read as a process of transcription. This transcription reveals phases of collaboration within a collective which are usually only recognized in their final formation of a solution. Making these phases of collaboration available is beneficial in the two ways outlined above: it can a) help discern patterns of relation in real-time and thus predict possible future movements, and b) enable a reflection on these patterns of captured intensity by establishing a semiotic system of reference which remains in flux.

Conclusion

The mode of listening introduced by the WDS and ML model, combines binary digital technology and Simondon's logic of individuation which, on the contrary, refuses to operate according to oppositions, negation, and solutions. Solutions are not of primary interest in Simondon's philosophy. His emphasis on relationality suggests a logic which regards every instant as equally important rather than focusing on final terms. The notion of individuation, indeed, implies that there are no final terms but only states in development. Solutions are never final or more potent than the transitional moments which harbor multiple points of view. These transitional phases are under-researched because dominant viewpoints such as substantialism and hylomorphism are based on the binary terms of substance or the lack thereof and form and matter, respectively. Within both of these traditions there are no tools which trace what Simondon terms the *pre-individual* since the individual is taken for granted (Combes, 2013, 2). The phase during which multiple viewpoints are active simultaneously tends to be overlooked in favor of solutions. The WDS and sequence transduction ML model are introduced as one way to approach these pre-individual, intense transitions by technological means.

Tracing intensity and affect within the relations of a collective through their breaths invites a different kind of analysis, a mode of non-binary listening which is not solely goal oriented or concerned with solutions. Gilles Deleuze, who was impacted greatly

by Simondon while formulating his philosophy of difference, summarizes a binary sense of listening as impoverished in the following way:

> "When we interpret differences under the category of opposition and as negatives, are we not already on the side of the listener, even that of the bad listener who hesitates between several possible versions of what was actually said and tries to find himself by establishing oppositions?" (Deleuze, 2001, 204)

Without establishing oppositions but rather multiplicities, the WDS and the sequence transduction ML model make it possible to "listen" and further investigate the intensity of perception and affect in process within the relation of individuating subjects. This mode of listening accommodates what Belgian philosopher Luce Irigaray (1995) has termed "non-reductive" (110) and she specifies:

> "I am listening to you not on the basis of what I know, I feel, I already am, nor in terms of what the world and language already are, thus in a formalistic manner, so to speak. I am listening to you rather as the revelation of a truth that has yet to manifest itself" (117)

She describes listening to a transition with regards to the formation of another subject and to the formation of a relation. When considering each breath as a non-lexical witness to relations, the WDS captures the act of listening alongside the act of being listened to in the collective breathing it traces. Within patterns of breath there are no "active" or "passive" acts, and they can, thus, be described as "non-reductive" in themselves. Amplified breathing recontextualizes a binary notion of communication as turn-taking by foregrounding the constant and simultaneous exchange of intensities during nonverbal communication which renders multiple viewpoints graspable. This study lays out how this oftentimes hidden non-binary dynamic of non-verbal communication can be applied to informatics and how bypassing the logic of "action-reaction circuits" of verbal communication acknowledges and surfaces relationality, affect, and intensity. The discovery of the breath as a modality which traces relational intensity without merely turning it into another signification, the introduction of the WDS, and the sequence transduction ML model which trains on singular data grant a reckoning of collective individuation. Together the breath, the WDS, and the sequence transduction model amount to a non-dualist approach which

combines mathematical and non-binary methods of analysis and which does not merely classify but identifies relational processes as intelligent behavior.

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