



## Research

### Exploring the Concept of Transduction to Interpret AI-Generated Images

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## Abstract

With the aim of contributing to the epistemological turn in the field of digital art history and cultural heritage studies, in a recent paper I introduced the idea of a techno-concept, defined as a co-production between machine rationality and human thought/imagination. Within this framework of discussion, this paper argues that the computational operations and corresponding information transformation processes that take place in latent spaces, especially multimodal latent spaces, can be explained as a transductive process, so that AI-generated images can also be understood as transductive phenomena. In this way, the concept of transduction, widely used in various scientific and philosophical fields, becomes a potential theoretical category for interpreting AI-generated images. The argument is based primarily on two concepts of transduction: The concept of signal transduction as used in the fields of biomedicine and biochemistry, and the concept of transduction proposed by Gilbert Simondon as part of his theory of individuation and differentiation. The paper concludes with some of the interpretive implications of approaching generative images as transductive phenomena.

**Keywords:** Techno-concept, Transduction, AI-generated images, Digital art history, Digital visual studies

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# 1. Techno-Concepts for a Renewed Epistemology of Culture

The progressive consolidation of Digital Art History as a specific field of study forces us to elaborate a new (or renewed) epistemic apparatus that provides us with intellectual tools to explain and interpret the new cultural phenomena that emerge as technology continues to evolve. To this end, in a recent paper I have introduced the idea of a techno-concept as a notion that could help shape such epistemological endeavors.<sup>1</sup>

Based on the well-established notion of technogenesis, the idea of a techno-concept postulates that the production of concepts cannot be considered independent of the technologies used to produce knowledge in any historical period, since they have co-evolved. Thus, a techno-concept refers to those intellectual productions in the form of ideas and/or concepts whose conceptual elaboration is mediated by the technology used for their operationalization. For example, our current way of understanding the mathematical concept of vector space cannot be separated from the kind of vector and latent spaces produced by deep learning technologies, and from the tools we create to visualize and understand how they are organized and operate. This understanding, in turn, shapes how and for what purposes we use them in the field of cultural analysis. For this reason, I argue that a techno-concept should be understood as a complex co-production between humans (the human/thought imagination) and technological entities.

In this context, this paper aims to make a preliminary approach to the concept of transduction as a techno-concept that could become a fruitful category for the explanation, analysis, and interpretation of AI-generated images. My argument is that the computational processes that take place in vector and latent spaces can be assimilated to transductive processes, or, in other words, that transductivity seems to be one of the main qualities of the production of generative images, that is, of their ontogenesis, but also of their modes of existence and operating logics. If this argument proves to be valid, then the concept of transduction, with all its epistemological and theoretical possibilities, could be incorporated into the explanation, analysis, and interpretation of generative images.

## 2. Concepts of transduction

The term and the concept of transduction have been used with different meanings in different fields over the course of time, including in the field of cultural analysis and interpretation. In the field of literary studies, the term has been widely used since Dolezel (1986) proposed a theory of literary transduction. In general, it is understood that the transformation of meaning that a given text undergoes when it is interpreted in different historical or social contexts involves a transductive component, since “a transmission of information with modification of meaning” is produced.<sup>2</sup> The concept of transduction has also found fruitful application in the arena of multimodal semiotics.<sup>3</sup> Yet, in these approaches, the distinction with the processes of intersemiotic translation is often unclear, since it is subsumed within the concept of transduction. Likewise, its contiguity with Julia Kristeva's concepts of intertextuality or Gérard Genette's transtextuality has also been argued. Similarly, the concept of transduction has been used in the field of the performing arts to explain the process of materialization, of bringing into action, theatrical, filmic or musical texts.<sup>4</sup>

Although a very common definition of transduction is to say that transduction is the process of transforming one type of energy into another, I would like to focus attention primarily on two conceptions of transduction that I believe have rich conceptual implications for understanding and interpreting the field of AI-generated images.

### 2.1. Signal transduction

The first concept is associated with the use of the term in the fields of biochemistry and biomedicine, and more specifically with what is called ‘signal transduction’. Signal transduction refers to an energetic transmission between cells that involves the transfer of new information into the cell. The integration of this new information with the information already present in the cell provokes intracellular changes that in turn generate a response (an action, a new signal, etc.). Thus, transduction is both the transmission of information and, more importantly, the process of transformation and production of a new signal/response. Generally speaking, in the case of dealing with generative processes of images (for example, images generated by Generative Adversarial Networks - GANs), it could be said that the computational operations trigger the transformation of the numerical information encoded in the vector and latent spaces into a visual

sign (the image we see on the screen). This process cannot be considered as a translation or transposition of a previous sign, as happens, for example, when a cultural object is recoded as a matrix of numerical information during the digitization process. In other words, the AI-generated image process seems to be better described as a transduction process rather than an intersemiotic process.

However, I think this phenomenon becomes even clearer in the context of text-to-image models. Take the stable diffusion model as an example: In the stable diffusion model, text embeddings are integrated into the latent space during the denoising process, which consists of a sequence of convolutions, with each convolution incorporating textual information that transforms the image embeddings (the latent visual information). This transformation then produces a new latent image (the new embeddings), which is processed by the next convolution, and so on. Thus, in this process, the former visual information is transformed by the incorporation of linguistic information, resulting in a new latent sign at the end. In a way, we could say that the final image embeddings produced conditioned by the text embeddings when trying to get an image that responds to a prompt (the stimulus) is the result of a transductive process.

## **2.2. Simondon's concept of transduction**

The second concept of transduction that I find extremely relevant is the one proposed by French philosopher of science Gilbert Simondon in the 1950s.<sup>5</sup> Transduction is the central component of Simondon's theory of ontogenesis. Indeed, transduction is the operation that makes possible the processes of individuation and differentiation, or in other words, the production of new realities in all dimensions (physical, biological, psychological, social). It is a conceptually very rich notion that conveys different but complementary meanings in Simondon's work.

On the one hand, transduction refers to a “dynamic operation by which a potential field of energy is actualized, moving from one state to the next in a process that individuates new materialities.”<sup>6</sup> If latent space can be informally defined as an internal and compressed representation of all the relevant features of a domain (encoded in numerical vectors), and thus as a model that encodes a representation of a cultural domain as a whole, then latent space could be understood as a field of (real) virtuality, as a field of potentialities or possible actualizations (the pre-individual reality or metastable system in Simondonian terminology) that will begin to happen when computational agents start to operate. This computational operation will produce concrete actualizations of “forces” in a particular form or shape. In fact, it is precisely the countless deployment of possible actualizations that defines the essence (the nature) of AI-generative works beyond their instantiation in a particular form or shape.

On the other hand (and complementarily), transduction is the dynamic operation that governs the process of becoming, which is the core of Simondon's theory of ontogenesis. According to Simondon and in contrast to Aristotelian hylomorphism—which still sustains our usual approach to cultural objects as entities that materialize and/or embody a pre-existing idea or content—individuals are not preconstituted, that is, there are no predefined entities (such as the matter and form of Aristotelian hylomorphism) that determine the substance or being of individuals; on the contrary, there are only processes of in-formation through which matter organizes itself by passing from one state (structural and energetic) to another. Thus, Simondon's focus is on the process of individuation and in-formation through which individuals come into being. In this context, transduction is the very process of passing from one state to another.<sup>7</sup> Moreover, the individual is constituted through a process of individuations that is never definitive (especially in the case of living forms). The individual is always in a process of becoming. Each individuation, understood as the concrete actualization of a field of possibilities, is a moment in a chain (past and future) of transformations.

In the light of this conception, I believe that the realm of generative images can be clearly explained as a process of becoming form, and thus as a transductive phenomenon. As I have said before, within the horizon of possibilities encoded in latent spaces (the metastable system), computational operations (acting as a structural germ) produce concrete actualizations of possibilities in a particular form or shape. Consequently, the generated images (the forms and shapes that we see and identify) could be considered as individuated forms that emerge from a field of numerical information through a process that we could consider immanent, to the extent that the latent space already has the potentiality of becoming that form. Moreover, the generated image (the individuated form) is never a final result, but only a point in a sequence, to the extent that the actual image can be transformed into another indefinitely. Generative images are in a continuous state of becoming, which has a very clear visual manifestation in the generative videos, where we literally witness the act of continuous transformation, the state of continuous becoming.

Likewise, as Deleuze points out in relation to the concept of transduction, the dichotomy between the general and the particular, which implies a vertical distribution of forms and matter, is replaced by a multiplicity of individual singularities resulting from the process of individuation. Thus, in this approach, transformation occurs by moving from one individual singularity to another individual singularity following a certain direction. That's why the exploration of latent spaces through specific paths, which involves moving from one particular latent embedding to another particular latent embedding could also be explained (in my view) as a transductive process.

### 3. Some interpretive implications

Thinking of AI-generated images as transductive phenomena has a number of implications for their interpretation that deserve more detailed exploration. In this paper I will mention only some of them.

Since there is no longer a substantive separation between form and matter, but rather a flow of information that individuates (acquires) form, the focus shifts from the forms and structures per se, what they are and what they mean, to the conditions that lead to a particular form and structure. The central question then is not how a content is materialized in a form, but how one meaningful form becomes another meaningful form, how signs and meanings are produced through the transductive process that goes from one singular materiality to another singular materiality. This means locating the problem of interpretation in the field of morphogenesis, topology, and ontogenesis.

Since, as a transductive phenomenon, the generative image we see is only a momentum between the past and a possible future, the center of interest is not (or not only) in analyzing or interpreting what the individual is here and now, but in what it will be in the future. That is, in its transformative capacity to become something new, a new reality. Thus, the meaning of an image does not lie in its origin, but in its destiny, in the future towards which it is projected.

Since transduction is fundamentally characterized by its processual nature, a performative approach to AI-generated images seems crucial. This means interpreting AI-generated images in their condition of events, of actions that occur as an entanglement of relations between different dimensions, systems, and elements. Indeed, in Simondon's thought, transduction also implies the relation between different orders of scale.<sup>8</sup> Individuation occurs as a process in which a heterogeneity of dimensions, systems, and elements of different scales enter into relationship. Thus, the individual is never an autonomous entity, but a complex system "in" relation, defined "in" such a relation.

This last question also has implications for the task of interpretation. In fact, transduction itself involves an interpretive process. The transducer has to interpret the meaning of the received sign/signal/information in order to act, to produce a certain response and/or action. But such interpretive action does not take place on a single level or field of possibilities, but on many different levels and scales simultaneously. When dealing with AI-generated signs, a number of transducers (human and non-human) and interpretive processes can be identified: The recoding of cultural objects into a set of vectors of numerical information and the constitution of latent spaces (both of which are in themselves the results of interpretive acts); the computational logic that interprets the information encoded in latent space to produce a latent sign (the image/text embeddings); the decoding of the final image embeddings into a RGB visual sign that we see on the screen; and the human subject that transduces this sign in two ways: The transformation of light energy into bioelectrical signals; and the transformation of the computational sign into a cultural and subjective sign, when he/she appropriates the newly produced form in order to give it a meaningful sense within the framework of a particular cultural and social context (or, in other words, as a cultural and social subject that he/she is), that is, when the generative form becomes a real sign for human beings. Therefore, there is a chain that combines intersemiotic and transductive processes, where interpretation, the production of meaning, is the result of complex assemblages of human and computational forces, and where the computational operations that produce the latent space and operate in the latent space are transformed (in another kind of transductive process) into subjective meaning.

Throughout this text, I have tried to show that transduction, a concept that is part of our intellectual and scientific tradition, can be reformulated as a techno-concept insofar as the computational processes involved in the production of AI-generative images can be assimilated or described as a kind of transductive phenomenon. Thus, the concept of transduction, with the heuristic and epistemological possibilities associated with Simondon's concept of transduction in particular, could be used as a category for analyzing and interpreting generative images in

accordance with their own transductive nature. In this way, the problem of interpretation is located in the realm of the processes of individuation (ontogenesis), becoming form (morphogenesis, topology, flux), and transitionality (change and transformation).

## Footnotes

1. Rodríguez-Ortega 2022. †
2. See also Izquierdo Arroyo 1980, Albaladejo 1998 and Albaladejo 2005. †
3. Kress 1997 and Kress 2010. †
4. Maestro 1996, Naves 2006, Llanos López / Piñera Tarque 2002, De Assis 2017. †
5. Simondon addresses the concept of transduction in three main texts: in the introduction to *L'individuation à la lumière des notions de forms et d'information* (1958, published in 2005); in a 1960 lecture entitled “Forme, information et potentiels” (Eng. tr. “Form, information and potentials” 2019); and in a 1962 lecture entitled “L'amplification dans les processus d'information” (Simondon 2015b, Spa. tr. Heredia 2016). My main source of reference has been *L'individuation* in its Spanish version Simondon 2015a. †
6. De Assis 2017; Simondon 2015a. †
7. Simondon 2015a. †
8. Simondon 2015a. †

## Cite as

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