

Body Model and Biosynthetic Devices: Interpreting Technological Incorporation with the Help of Edmund Husserl's Genetic Phenomenology

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Abstract: The body model is a relatively new concept, which originates from the science of human embodiment. Cognitive neuroscientists and psychologists that work in this research field usually interpret the concept of body model as an internal model or reference description of anatomical, volumetric and structural properties of human corporality. It has been demonstrated that the body model plays a normative role in shaping a pre-reflective sense of body ownership, which is centrally involved in the lived experience of incorporating ('phenomenal incorporation') medical devices, such as prostheses or implants. Further investigation is required to understand the normativity of the body model, especially in relation to the emerging generation of so-called biosynthetic devices designed to lead physiological and phenomenal incorporation to a qualitatively higher degree compared to traditional medical devices. The main objective of this article is to contribute to a critical analysis of the normative role of the body model in the phenomenal incorporation of biosynthetic devices. My starting point is an interdisciplinary methodology, which is inspired by that developed by postphenomenologists such as Don Ihde and Peter-Paul Verbeek. I will adopt, however, a classically inspired critical perspective of which postphenomenology has proved to be lacking. More specifically, I will use as a reference frame for critical analysis the genetic phenomenology of human embodiment, which was developed by the founder of classical phenomenology, Edmund Husserl, in a mature phase of his production.

Keywords: body model, body ownership, technological incorporation, genetic phenomenology, Edmund Husserl, biosynthetic devices

INTRODUCTION

The concept of body model is a relatively recent acquisition of the science of human embodiment. Cognitive neuroscientists and

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psychologists active in this field of research interpret the concept as referring to a diachronic non-individual-specific internal model or reference description of the anatomical, volumetric and structural properties of human corporality (Tsakiris and Haggard 2005). These properties are the shape and surface of the body, as well as the location, limits and internal compositional relationships of the body parts. It has been shown that the body model pre-exists with respect to events of sensorimotor or multisensory correlation and crossmodal integration, providing that set of background conditions, which are necessary for the preservation of a coherent own-body perception by the human being (Tsakiris and Fotopoulou 2008). Over the last decade there has been an important increase in empirical research, which has shed light both on the neurobiological substrate and on the functional mechanism of the body model (Chancel and Ehrsson 2020). The former appeared to coincide with patterns of neural activity located in the right temporo-parietal junction (Tsakiris, Costantini and Haggard 2008) – alternatively, it was suggested that the internal model might be operated by bimodal and multimodal neural populations in the area 5 of the primate parietal cortex (Maselli and Slater 2014). The latter overlaps with a test-for-fit process used to filter sensorimotor or multisensory input, and hence to discriminate between events that may be assigned to one's own body and events that trigger a mismatch – because of their association with other physical or human bodies that co-habit the same environment (Tsakiris 2010).

Foundational research has also produced notable results. In this case, the attention of the researchers focused on conceptual distinctions, such as those that exist between the body model, on the one hand, body schema and body image, on the other.¹ It has also been shown that the body model plays a normative role in shaping a pre-reflective sense of body ownership addressed at the properly physical dimension of one's own body (De Preester and Tsakiris 2009). The dynamic characteristic of reconfigurability of the body model was found to be central in the incorporation of external objects, interpreted as a lived process of modification of the sense of body ownership ('phenomenal incorporation'): by reconfiguring itself, in fact, the model activates or inhibits the aforementioned process, for example

¹ The body schema and the body image coincide with an operational performance of the body that structures the coupled body-environment system and a reflective sense of one's own body mediated by sensory perception, cognition, emotions, socio-cultural standards and interpersonal dynamics, respectively (see Gallagher 1986).

where medical devices, such as prostheses or implants, are attached to or implanted in the human body.

In this direction, despite the progress of the research just outlined, further investigations are necessary to fully understand the normative role of the body model in relation, in particular, to the so-called biosynthetic devices, designed to achieve a qualitatively higher level of incorporation than that obtained with classical medical devices (Froese 2014). Biosynthetic devices are highly engineered artifacts or technological products based on advanced theories and techniques of Artificial Life, a field of research and innovation focused on the computational simulation and robotic synthesis of fundamental biological processes (Steels and Brooks 1993). In biosynthetic devices organic and inorganic components and/or materials are integrated to improve the biocompatibility of the artifact (Menciassi, Takeuchi and Kamm 2020), i.e. the property of being integrated into the human body not only locally (tissues surrounding the annexation or implant), but also globally (whole body). This seems to facilitate the physiological as well as the phenomenal incorporation of the device: with regard to phenomenal incorporation, biocompatibility might induce an effect of reduction in the reconfiguration of the body model, forcing a loosening of its normative function. Some examples of biosynthetic devices are neural prostheses, the so-called organ-on-a-chip technology and self-assembled tissues produced with 3D bioprinting techniques (Luo, Weiss, Liu and Tian 2018).

In this article I intend to contribute to a critical analysis of the normativity exercised by the body model in reference to the individual pre-reflective sense of body ownership modified by the implantation of biosynthetic devices. My starting point is an interdisciplinary methodology, which is inspired by that developed by postphenomenologists such as Don Ihde and Peter-Paul Verbeek (Ihde 1993; Rosenberger and Verbeek 2015). I will adopt, however, a classically inspired critical perspective of which postphenomenology proved to be lacking (Properzi 2021). More specifically, I will use as a reference frame for critical analysis the genetic phenomenology of human embodiment, which was developed by Edmund Husserl in a mature phase of his production, focusing on the genetic solipsistic structure known as ideopsychic quasi-causality (Husserl 1989; 2001). I will apply this structure to a case study that I consider of particular interest as it is one of the few examples of advanced clinical translation of a biosynthetic device accompanied by a systematic tracking of the

user-patient experience: the case of the implantation of biosynthetic extracellular matrices (ECMs) capable of regenerating the damaged organ in patients suffering from blindness induced by the irreversible loss of optical quality of the cornea (Fagerholm et al. 2010).

PRE-REFLECTIVE SENSE OF BODY OWNERSHIP AND THE BODY MODEL

In the current scientific literature, body ownership is considered as one of the two components of human embodiment understood as a minimal, sub-personal sense of self (Tsakiris, Schütz-Bosbach and Gallagher 2007). It is defined as an affection, a feeling, a pre-reflective sense of being mine ('mineness'), experienced by the individual in relation to the physical or material-real dimension of one's own body (Gallagher 2000). The other component, agency, depends on the body schema and coincides with a pre-reflective sense of being-agent, that is, the cause of the initiation, control and/or inhibition of a given action (Vignemont and Fournier 2004). In both cases we are dealing with pre-reflective senses that do not involve conceptualisation processes, but rather a-thematic body representations that can also be connoted as implicit (Synofzik, Vosgerau and Newen 2008).

The elaboration of the experimental paradigm, known as Body Ownership Illusions (BOI), was decisive to study body ownership in experimental terms. The BOIs are characterised by the use of sensorimotor or multisensory stimulation, typically tactile-visual (a)synchronicities, to alter the own-body experience of the participants (Kilteni, Maselli, Kording and Slater 2015). They thus guarantee the comparison between verification conditions, in particular between the presence of one's own body (condition to be corroborated) and the absence of the same (control condition). BOIs are generated both in relation to parts of one's own body, as in the well-known illusion of the rubber hand (Botvinick and Cohen 1998), and in relation to one's entire body, as in the illusion of body exchange (Petkova and Ehrsson 2008). Vision, touch and kinaesthesia are involved in the rubber hand illusion: the participant looks at a rubber hand while it is being stroked simultaneously to his/her hand, which is hidden from view. The integration of visual, tactile and kinaesthetic signals determines the attribution of the alien hand to its own corporality. According to the well-known expression of Botvinick and Cohen (1998, 756), the rubber hand is "felt as if it were my hand". In analogous terms, in the illusion of body exchange, the mislocalisation – in this case of the

whole body experienced as one's own – is elicited by synchronous tactile-visual stimulations: the illusion is generated thanks to the use of a humanoid mannequin, manipulating the visual first- or third-person perspective of the participant (Petkova, Khoshnevis and Ehrsson 2011).

Intended as an experimental paradigm, BOIs have allowed researchers to elaborate various theoretical proposals aimed at explaining and/or predicting the sense of body ownership (Tsakiris 2010). The pioneering study by Tsakiris and Haggard (2005) highlighted the existence of conditions that limit the generation of BOIs. More specifically, they would coincide not only with spatiotemporal incongruencies (i.e. different spatial configuration between the external object and the natural body or the natural limb as well as stimulatory asynchrony), but also with a morphology and a posture of the external object, for example of the mannequin or of the rubber hand, which are not homologous, respectively, to those of one's own body or of a body part of the participant. The identification of these conditions led the researchers to abandon the dominant theoretical approach focused on multimodality-crossmodality and to elaborate a more complex theoretical proposal, which is able to combine two orders of processes: the bottom-up processes of sensorimotor or multisensory correlations and of crossmodal integrations and the top-down processes of the body model. It has been proved, in particular, that processes of reconfiguration or internal reorganisation of the body model are present in the event that the perceptual illusion actually takes place (Moseley et al. 2008). This reconfiguration involves a so-called egopetal process consisting in the appropriation of the external object (Longo et al. 2009). The body model would exercise a normative role of structural modulation and content filtering with respect to the sense of body ownership modified by the incorporation of external objects. This role has been demonstrated to be active on a double level, as well as being internally divided into a double component (De Preester and Tsakiris 2009). The double plan of intervention of the body-model coincides with the double material and formal dimension of the sense of body ownership. Not only the content, therefore, but also the content-independent structure of the mineness experienced by the perceiver would be subject to an autonomous internal regulation, pre-existing to the stimulatory event and to the regularities that co-determine its course. The dual normative component has, instead, been identified in the

inhibition (negative component) or in the activation (positive component) of the incorporation of external objects.

PHENOMENOLOGICAL PERSPECTIVES ON TECHNOLOGICAL INCORPORATION

The scientific results that I briefly retraced in the previous paragraph are today at the centre of a lively debate linked, in particular, to the philosophical movement, known as postphenomenology (Ihde 1993). Postphenomenology is presented as a philosophical style of investigation that places science and technology at the centre of its analytical interest. The main objective of postphenomenology is to systematically address, from within the tradition of phenomenological philosophy, the plexus of issues concerning the role played by artifacts or technological products in the bodily-perceptual constitution of the human surrounding environments (Ihde 2010), and more in general in the (inter)personal constitution of cultural worlds (Selinger 2006). Postphenomenology, therefore, pays attention to technology as a force capable of shaping human lived experience, making use of an interdisciplinary methodology characterised by a strong empirical root, an aspect that gives it a very peculiar position in the field of postmodern philosophical studies (Rosenberger and Verbeek 2015a). In postphenomenological methodology, the conceptual analysis of phenomenological style is applied to empirical case studies of high informative value, based on a reworking of the principles and methodical operations of classical phenomenology conducted in a pragmatic direction (Rosenberger 2017). Postphenomenological investigations have affected a wide variety of technological domains including, mainly, the biomedical domain, with interesting studies devoted to the incorporation of different kinds of prostheses into the human body (De Preester 2011). Postphenomenology developed in a very branched way into sub-theories, the main one being mediation theory. The central idea of mediation theory is that technological devices play a mediating role in the human-world relationship, interpreted as a resulting dynamic of the relations between human beings and technology (Verbeek 2015). Mediation theory has been interested in the phenomenal incorporation of technological devices, proposing a series of conceptual distinctions and useful conceptual classifications. For example, the distinction between the relation of fusion, in which devices merge with the human body into a new hybrid being, and the relation of augmentation where devices merge with the

environment into so-called smart environments. Both fusion and augmentation have been classified as cyborg relations: as such, they are irreducible to the instrumental relations of use of the devices (Verbeek 2008).

Despite the results achieved, postphenomenology and mediation theory have proved ineffective to address in sufficient depth the dimension of technological normativity, more specifically, to assess norms constituted within human-technology relations (Boshuijzen-van Burken 2016). This limitation was found to depend on the inability to validate, to rationally justify the conceptual position embraced regarding technological normativity (Zwier, Blok and Lemmens 2016). As previously anticipated, in this article I propose an alternative path to that pursued by postphenomenologists and mediation theorists. This path is characterised by the presence of a critical aspect that integrates the postphenomenological methodology through the recovery of a component of Husserl's phenomenological method, the genetic component. Here, two important points should be remarked. First of all, as I will clarify in what follows, the genetic insight returns a concrete-practical dimension to the critical investigation of Husserlian phenomenology the (presumed) absence of which is at the basis of the pragmatic reorientation of the same attempted by postphenomenologists. The latter is in fact based on a fundamental observation carried out in relation to the Husserlian approach, according to which the analytical focus maintained on the essential units and relations of lived experience, which are by their very nature universally valid units and relations, would prevent classical phenomenology from understanding the human-technology relations in their concreteness, peculiarity or, better said, uniqueness (Rosenberger 2017). This suspicion of essentialism, however, leaves a distinctive feature of Husserl's methodological reflection in the shadow – and here I insert the second remark: the complexity, that is, of interpretation and articulation of the critical instance. This aspect has been ignored by recent trends in contemporary phenomenology, such as naturalized phenomenology (Albertazzi 2018), and, above all, postphenomenology (Zwier, Blok and Lemmens 2016). According to what I will be able to illustrate shortly, it is nevertheless central in Husserl's work, where it depends on the variety of formulations to which the critical analysis is subjected, formulations that are systematically harmonised within the framework of a unitary methodology.

THE GENETIC METHOD, THE THREE HUSSERLIAN INTERPRETATIONS OF THE CONCEPT OF GENESIS AND THE GENETIC PHENOMENOLOGY OF HUMAN EMBODIMENT

The classical methodology of Husserlian matrix is based on the interaction of three components, namely the descriptive component, the constitutive component and the genetic component. These components are interrelated in systematic terms in the light of a complementary relationship established between the so-called static and genetic method (Husserl 2001). The static method includes phenomenological descriptions and constitutions. By carrying out the former, the phenomenologist analyses the structures of lived experience in detail in terms of its correlated intentional elements, namely the act-process (noesis) and what is understood by this as an objective sense (noema). Phenomenological constitutions, instead, allow us to understand the processes by which the objective senses are synthesised or unified in the object of experience – interpreted as an instance of the noematic sense. Between 1917 and 1921 Husserl begins to distinguish a genetic component of the phenomenological method. The genetic method (*genetische Methode*) is used to expand static constitutions from a time-dependent perspective and is now presented as distinct and complementary to the static one (*statische Methode*), previously identified with the phenomenological method *tout court*. Accordingly, the genetic method broadens the spectrum of phenomenological investigation. The intentional structures of consciousness are no longer simply described and/or studied in constitutive terms by the phenomenologist but are also ‘explained’ by means of if-then relationships of a motivational kind.² Genetic explanations are thus non-naturalistic (i.e. non-causal) explanations: as motivational or pure (*rein*) explanations, they allow the phenomenologist to understand how a given experience becomes structured, that is, how it assumes its characteristic intentional configuration, with a noetic pole and a noematic pole.

At least three interpretations of the concept of genesis can be identified in Husserl's vast and complex work. More specifically: 1) the ‘primordial’ or passive genesis; 2) the active genesis, and 3) the genesis that is active and passive at the same time (Steinbock 2018). The distinction between passivity and activity here concerns the

² By motivation here we mean both “the inner lawfulness of consciousness”, and the “central methodological principle of genetic phenomenology” (Pugliese 2018, 91).

affective character of the genetic process or its spontaneous character. The process can also take place between activity and passivity, therefore, as a genesis that is both active and passive.

Compared to the phenomenological studies Husserl carried out during the first decade of the XX century, the genetic investigations of the '20s and '30s undoubtedly represent a more in-depth analysis of human embodiment, which is indeed scrutinised as springing up from a primitive kind of inner time-consciousness, i.e. association (*Assoziation*). According to Husserl (2001, 162), therefore, association “does not characterise a form of objective, psycho-physical causality, as it does for psychologists”, being instead a temporal synthesis. The identity of the object as an object that has duration (temporal continuity) implies connecting, associating impressions that determine the present moment of consciousness – the so-called ‘living present’ (*lebendige Gegenwart*) with the corresponding retentional and protensional phases of the immediate past and the immediate future – to mnemonic reproductions of past impressions and imaginative anticipations of expected future impressions. Husserl described association from a formal as well as a material point of view. The form of associative consciousness is a form of ordering, the form of succession (being antecedent-being posterior in the temporal order), which structures the object as a continuum in the temporal sense of duration. The matter of associative consciousness is the discrete sensory datum informed by the succession and by a subordinate form not of ordering but of field indicated as simultaneity (i.e. being co-existing in a sensory field or among several sensory fields). Husserl called the sensory datum *hyle*.³

³ The term ‘*hyle*’ was introduced by Husserl in §85 of the first book of *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy*. Husserl here detects two meanings that are not adequately differentiated in the ordinary use of the adjective ‘sensory’, which, indeed, refers to both what is mediated through the senses in the external perception and the qualitative-sensory content of the perceptual object. In order to highlight the difference between the two meanings, he proposes the adoption of the Greek word ‘*hyle*’ for the first: i.e. hyletic data are the contents of sensory functions and, as such, are distinct from the sensory qualities of the perceptual object. Husserl sees in them two specular sides, the theoretical and the practical one, identifying two different groups of hyletic data, namely the group of sense-data and the group of feeling-data (See Williford 2013 for details).

On this basis, the author examined a series of associative structures (fusion, contrast, similarity, dissimilarity, homogeneity, heterogeneity and gradation), describing them mostly in pairs according to a logic of opposition (fusion vs contrast; similarity vs dissimilarity; homogeneity vs heterogeneity). The phenomenon of hyletic prominence, originating from the associative structure of contrast among successive and/or co-existing hyletic data, brings out a basic level of body consciousness, i.e. kinaesthesia (Husserl 2001). Kinaesthesia selects prominent hyletic data from the link of temporal association according to a motivational nexus, the so-called kinaesthetic motivation, which is genetically constitutive for the sense fields (Husserl 1989). Sensoriality has an environmental as well as a proper-bodily direction linked, in particular, to the tactile field. As asserted by Husserl (1989, 154): “Necessarily bound to the tactual perception of the table (this perceptual apprehension) is a perception of the body, along with its concomitant sensation of touch”. Human embodiment as lived experience depends on the localisation ‘on or in’ the body of the hyletic data made possible by touch. In fact, unlike the finger that touches, the eye that sees, for example, does not locate the respective data. There is certainly a field of visual localisation. However, it is gained in a mediated way, that is, through kinaesthesia and touch: “An eye does not appear to one’s own vision [...] We do not have a kind of extended ocularity such that, by moving, one eye could rub past the other and produce the phenomenon of double sensation [...] Actually, the eye, *too*, is a field of localisation but only for *touch sensation*, and, like every organ ‘freely moved’ by [the] subject, it is a field of localised muscle sensations” (Ibid, 155-156).

THE SOLIPSISTIC GENETIC STRUCTURE OF IDEOPSYCHIC QUASI-CAUSALITY

The kinaesthetic-visual embodiment that I briefly outlined in the previous sub-paragraph was characterised by Husserl as solipsistic: it does not coincide with the phenomenon *tout court*, which, in fact, also has an intersubjective genesis in empathic experience (Depraz 2001). An important integration of the experience of embodiment is due to the intersubjective genesis, which is articulated along a double line. First of all, the expansion of the possibility of locating hyletic data “on or in” one’s own body, which is the body both of the experiencer (as an ‘other’ individual embodied as a term of empathic experience) and of other individuals empathised by the same. Secondly, the emergence of

the plexus of psychic states and processes involving the aforementioned data. The body as a real bearer of the psychic dimension (*Träger von Psychischem*) is the object of study of psychology, which, within the systematics of natural sciences elaborated by Husserl, appears as a specular discipline to physiology, which is intended as the study of organic functions of the body precisely in its physical or material-real dimension. Both disciplines branch out from somatology, the natural science of the body-proper interpreted as a space of localisation of sensory data (Husserl 1989).

The genetic-phenomenological grounding of psychology, as a natural science, is traced by Husserl to two solipsistic structures: physical-psychic conditionality and ideopsychic quasi-causality. Such structures are often presented by Husserl in the context of a critical discussion of parallelism and interactionism, conceived as competing theoretical positions at the level of naturalistic explanation of the mind-body problem. Physical-psychic conditionality and ideopsychic quasi-causality are opposite and complementary structures. Physical-psychic conditionality concerns the dependence of the psychic on the physical dimension: “It is well known that the psyche depends on the body and thereby on the physical nature and its many relationships. First of all, this dependency exists throughout with regards to the totality of sensations (including the sensuous sensations of feeling and instinct) and further also with regard to their concomitant reproductions, and thereby the *whole life of consciousness is affected by this dependency*” (Husserl 1989, 142-143). Ideopsychic quasi-causality, on the other hand, concerns the self-dependence of the sensory psychic dimension on the totality of psychic states and processes that exercise a normative regulation: “*Within one and the same soul, the present stock of lived experiences, as a totality, is dependent on earlier stocks of lived experiences [...] even where a sensation occurs as ‘an effect of external stimulation’, the mode of its acceptance into consciousness is co-determined by this new regulation*” (Ibid, 143; italics original).

As anticipated, in the next paragraphs I will propose an application of the normative regulation of ideopsychic quasi-causality in order to clarify the role played by the body-model in the incorporation of biosynthetic devices, in particular of the latest generation corneal implants.

A CASE STUDY: BIOSYNTHETIC CORNEAL EXTRACELLULAR MATRICES (ECMs)

The cornea is the protective frontal part of the human eye responsible for transmitting and refracting incident light rays that are focused on the retina by the lens, i.e. the natural lens of the eye. The irreversible loss of optical quality of the cornea, i.e. the loss of its transparency due to disease and/or damage, is the second cause of blindness in humans and is typically addressed either with corneal transplantation or with the use of synthetic prostheses (Whitcher, Srinivasan and Upadhyay 2001). However, the gap between the availability and demand of the transplantable organ, on the one hand, and the complex implantation procedures as well as the frequent post-operative complications, on the other hand, have highlighted the need to pursue new therapeutic approaches, attempted, above all, in the field of regenerative medicine.

Towards this end, a research group active for over a decade in Sweden, Canada and the United States first developed in the laboratory and then tested on animals and humans a corneal metaplast, consisting of biosynthetic corneal extracellular matrices (ECMs) (Fagerholm et al. 2010). Once implanted in the eye, the biosynthetic ECMs have the ability to regenerate the damaged organ, emulating the functions of the natural ECMs, which constitute the part of the tissues not composed of cells. Like the natural ones, biosynthetic ECMs are made of a biopolymer (recombinant collagen of human origin). Unlike natural ECMs, however, they are devoid of cellular filling to ensure the repopulation by the cells of the natural organ and thus prevent reactions of rejection (1-2). As the results of the aforementioned study suggest, the biosynthetic ECMs, which were first tested on animal subjects and then implanted in a group of ten human subjects, were shown to be stably incorporated by the patients in the long term (two years of follow-up), leading to an improvement in the pre-pathological visual capacity in six out of ten patients tested as well as to the regeneration of the epithelium, nerves, stroma and tear film in all the subjects involved in the study (6-7).

The tracking carried out of the user-patient experience gives a particular value to biosynthetic ECMs as a case study to begin a critical reflection on an advanced topic of body normativity. It seems to me that this reflection should be oriented on a particular aspect: the existence or not of a relationship between the increased biocompatibility of the device and the reduction of the reconfiguration of the body model. The latter would seem to imply a loosening of the

morphological, anatomical-postural and informational-structural normative constraints imposed by the model on the modification of the pre-reflective sense of body ownership, a modification that in our case would be connected to the phenomenal incorporation of biosynthetic ECMs. As I will attempt to outline in the next section, the solipsistic genetic structure of ideopsychic quasi-causality allows us to shed light on this phenomenon of functional loosening of the body norm.

GENESIS OF THE BODY NORM IN THE PHENOMENAL INCORPORATION OF LATEST MEDICAL DEVICES GENERATION SUCH AS BIOSYNTHETIC CORNEAL ECMs

The brief presentation given in § before the case study provides a somewhat abstract description of the structure of ideopsychic quasi-causality. To give greater substance to this description it is necessary to characterise both the hyletic basis and the psychic totality in relation to the case study selected. Towards this end, the sensory data that interest us are kinaesthetic-visual data (re)acquired by the user-patient thanks to the implantation of biosynthetic ECMs and to the anatomical-functional regeneration made possible by the matrices themselves. The totality of psychic states and processes to which reference is made coincides with the body model itself, understood as an internal description of the anatomical, volumetric and structural properties of one's own body composed of both static elements (anatomical, volumetric and structural representations) and dynamic elements (processes of reconfiguration of the body model). Following this characterisation, it is possible to trace the genesis of the body norm in implanted users-patients, and hence to try to understand if there is a phenomenon of functional loosening of the body norm regulating the phenomenal incorporation of biosynthetic ECMs. This attempt can only involve a passive level of experience and, therefore, can call into question that interpretation of the phenomenological genesis that we have seen to have been connoted by Husserl as primordial, as it refers not to an egological activity but to the affectivity of the body that is a precondition of that activity.

As in any genetic investigation conducted at a passive or primordial level, the starting point is given by the formal structure of the present of consciousness, while its development involves the associative propagation of the same along a double direction: the temporal direction of the past, which can be reproduced mnemonically, and of the expected future through anticipations, and the direction of

coexistence in one or more sensory field structures, integrated in the synthesis or unity identifying the percept. Compared to a non-pathological conscience, the living present of users-patients treated with biosynthetic ECMs is characterised by kinaesthetic-visual impressions, retentions and protensions equipped with greater motivational strength due to the intensification of the prominence of the data. This intensification depends on a phenomenon of contrast that we could define as hyper-structured. Not only because it provides the involvement of the hyletic basis, but also the involvement of the mnemonic reproduction of a sense of lacking-of directed towards the aforementioned basis that is felt by the perceiver in the pathological state of blindness, which, precisely, contrasts and is in conflict with the presence of the sensory content in the impression that determines the present moment of visual consciousness, its living present. A first moment in which the (quasi-)causation or motivational force exerted by the body model can be said to be active is this living present of the kinaesthetic-visual consciousness of the user-patient, a present that, as we have just seen, is structured not only according to the form of ordering of the internal succession of the immediate temporal phases, but also according to the form of ordering of the external succession of present and past moments that distinguishes consciousness as a reproductive association.

That a normative regulatory value is connected to this consciousness and that this value can help to clarify phenomenal aspects of the process of reconfiguration of the body model in technological incorporation, can be explained, in my opinion, by recovering an interpretation of the norm as ideopsychic optimisation, which has been suggested by Husserl (2001, 252-262) in the context of a genetic investigation conducted on the verification of mnemonic impressions. Intended as a (re)constitutive process, the verification or ascertainment of the past impressional data reproduced in the current present of consciousness reveals a sense of the norm that can be said to be embodied because it coincides with (the ideal of) a complete pre-reflective appropriation, which is therefore passively or bodily lived, of an already realised psychic course that is accessible by the experiencer as a whole (Ibid, 256). The body norm thus conceived expresses an ideal that can be approached in the light of a gradation of moments of passive experience. This phenomenon of passive experiential gradation shows a double internal articulation: on the one hand, the progressive intensification of the motivational force exerted on the living present

of consciousness by the psychic totality and, on the other hand, the progressive internal differentiation of the correlated noetic-noematic components of the lived experience (Ibid, 256-259). In the case in question, the sense of the body norm just described (i.e. ideopsychic optimisation), together with the corresponding phenomenon of gradation, appears in connection with the motivational action exercised by the model on the present of the kinaesthetic-visual consciousness of the user-patient. In fact, the determination of the sensory content of this consciousness is conditioned by the pre-reflective appropriation that the perceiver gains with regard to the entire series of reconfigurations of the body-model, an appropriation that occurs concurrently first with the entry and then with the exit from the pathological state of loss of visual function.

It has already been noted that the determination of the sensory content or hyletic data of the living present implies that the kinaesthetic-visual consciousness of the user-patient is structured as a reproductive connection or association, acquiring a temporal form that extends along the direction of the past of consciousness. This temporal form is not the only one linked to the normative regulatory aspect of the body model. In fact, there exists a temporal form that extends along the direction of the future of consciousness, which, in analogy to the one previously illustrated, consists not only in the form of ordering of the internal succession of the immediate temporal phases, but also in the form of ordering of the external succession of present moments and future moments. Both of these forms are distinctive of consciousness as an anticipatory association (Ibid, 263-269). Understood as a psychic totality, the body model motivates an imaginative prefiguration or anticipation in the present of the kinaesthetic-visual consciousness of the user-patient. This prefiguration makes it possible to configure a set of data that we could define as pre-prominent, as not yet highlighted, precisely as prominent data, by the (recovered) kinaesthesia of vision. The pre-prominent data and the structure of the anticipatory association, to which they belong to, provide a first organisation of consciousness to the preconceptual categorisation implied by the sense of body ownership. It is in this organisation that there is a new expression of the body norm as ideopsychic optimisation and of the corresponding phenomenon of passive experiential gradation, an expression rooted in the close interconnection existing between the body model and the body schema (refer to the second §). According to this new declination, the body norm coincides with (the ideal of) a

complete pre-reflective appropriation of the crossmodal synthesis – not yet of the perceptual object –, in particular of the physicality or materiality of one's own body and of the environmental bodies seen as kinaesthetic-visual units. As in the case of the body norm relating to consciousness as a reproductive association, also in this case the norm is approachable in the light of a gradation of moments of passive experience. In consciousness as an anticipatory association, the phenomenon of gradation shows the known double internal articulation, although the progressive intensification of the motivational force as well as the progressive internal differentiation of the correlated noetic-noematic components are here due to the action exerted by the crossmodal synthesis prefigured in the current present of consciousness by virtue of that psychic totality, which is the body model – as an internal description interconnected with the body schema.

The coexistence of impressions in the sensory fields, as well as the coexistence of the same fields that structure the user-patient consciousness as perceptual consciousness, represents a new sphere of action of ideopsychic normative regulation exercised by the body model. This action is carried out on a hyletic basis informed by a more complex field (and between fields) organisation of a higher level than that organisation of the ordering characteristic of temporal succession as a form of associative consciousness. It is at this level that the normative role exercised by the body model affects the phenomenal incorporation of external objects, activating or inhibiting the plasticity of body ownership, according to those constraints that have been mentioned in the previous paragraphs. The high biocompatibility of biosynthetic corneal EMCs does not cause a loosening of the morphological, anatomical-postural and informational-structural constraints imposed by the body model, since the devices not only emulate the functionality of natural ECMs but actually regenerate the natural organ (refer to the preceding §). At least in this case, therefore, the increased biocompatibility of the biosynthetic device compared to a classic device does not involve a reduction in the reconfiguration of the body model following its incorporation. This means that there is no functional loosening of the body norm interpreted as regulating the activation or the inhibition of the plasticity of the pre-reflective sense of body ownership.

The investigation carried out in this paragraph shows that, if there are nuances of the norm expressed by the body model in cases of the

incorporation of biosynthetic ECMs, this phenomenon does not concern the loosening of the morphological, anatomical-postural and informational-structural constraints imposed by the body model. It rather concerns the pre-reflective appropriation, passively experienced, of the body model itself, understood as a psychic totality given in the past of the kinaesthetic-visual consciousness of the user-patient. This phenomenon of passive experiential gradation also concerns the pre-reflective appropriation of the body precisely in its physical or material-real dimension and of the environmental bodies, interpreted as crossmodal syntheses to which the kinaesthetic-visual consciousness of the user-patient has access in his/her next, future development.

CONCLUSION

In the present article I proposed an investigation concerning the normative role exercised by the body model in the incorporation of the latest generation of biosynthetic devices, namely biosynthetic corneal ECMs. To this end, I made use of the normative regulation of ideopsychic quasi-causality, identified by Husserl in the context of his genetic phenomenology of human embodiment. The interdisciplinary methodology adopted was inspired by that developed by postphenomenologists and mediation theorists, distinguishing itself for the adoption of a critical perspective of which postphenomenology and mediation theory have proved to be lacking. I focused my attention on the alleged phenomenon of functional loosening of the body norm, a phenomenon that turned out to be inconsistent with genetic-phenomenological data on user experience. The results achieved are certainly not exhaustive concerning the complexity of the normative issue addressed. However, taking into account the high informative value of the case study selected, which, in fact, exemplifies the small group of cases in which biosynthetic devices have reached the phase of clinical translation with a systematic tracking of the corresponding user-patient experience, these results may be evaluated as a first, initial step towards a systematic treatment of the normative issue connected to the phenomenal incorporation of an emerging class of medical devices.

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