

# Overlaps between neuroscientific and philosophical perspectives on bodily resistance in the digital

Chevauchements entre les perspectives neuroscientifiques et philosophiques sur la résistance corporelle dans le numérique

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## Abstract:

This paper is finding ground in neuroscientific research for revealing the body's resistance to dystopian narratives on the body submitting to the virtual. Contemporary research in cognitive neuroscience is studying the relations between the self and embodiment by designing speculative body images and transferring the subjects' perceived embodiment into them. Together with the modifications in the subjects' perception of their own bodies, various transformations in the virtual space which are independent of the digital code occur.

Putting in dialogue models of embodiment resulting from the research with aesthetic theories reveals the embodiment's agency in the digital. Virtual space, as suggested by the media theoretician Peter Weibel, is a sensory realm. It is a sphere conditioned by embodied human perception. Therefore, it can be approached as a laboratory for the study of human senses, the body and their agency. The impact of out-of-body illusions on the perception of virtual spaces can, thus, be studied as a creative act. The body, thus, opposes the conventional narratives of its exclusion from the virtual and of its dangers to the embodiment. The perceived virtual embodiment organizes and defines virtual spaces independently of the digital code. The spaces emerging from the perception in the virtual resist previous experience with physical spaces. They diverge

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from Euclidean space, their functioning and form are fully dependent on the human embodied perceiver. The body resists the power of the digital.

The neuroscientific research updates aesthetic theories of space perception dating back to the 19th century. These theories attributing the central role to the body were informed by the entanglements with scientific study of human perception, in psychophysics or experimental psychology. The theories formulated by the scientific disciplines were adopted by aesthetics where they persisted until they have proven their full potential in digital media.

*Key words: embodiment, neuroscience, aesthetics, virtuality*

**Abstract:**

Cet article s'appuie sur la recherche neuroscientifique pour révéler la résistance du corps aux narratifs dystopiques de la soumission du corps au virtuel. La recherche contemporaine en neurosciences cognitives étudie les relations entre le soi et l'incarnation en concevant des images corporelles spéculatives et en y transférant l'incarnation perçue des sujets. Parallèlement aux modifications de la perception des sujets de leur propre corps, diverses transformations de l'espace virtuel se produisent indépendamment du code numérique.

La mise en dialogue des modèles d'incarnation résultant de la recherche avec les théories esthétiques révèle l'agence de l'incarnation dans le numérique. L'espace virtuel, comme le suggère le théoricien des médias Peter Weibel, est un domaine sensoriel. C'est une sphère conditionnée par la perception humaine incarnée. Par conséquent, il peut être abordé comme un laboratoire pour l'étude des sens humains, du corps et de leur agence. L'impact des illusions de hors-corp sur la perception des espaces virtuels peut ainsi être étudié comme un acte créatif. Le corps s'oppose ainsi aux récits conventionnels de son exclusion du virtuel et de ses dangers pour l'incarnation. L'incarnation virtuelle perçue organise et définit les espaces virtuels indépendamment du code numérique. Les espaces qui émergent de la perception dans le virtuel résistent à l'expérience antérieure avec les espaces physiques. Ils divergent de l'espace euclidien, leur fonctionnement et leur forme dépendent entièrement du perceuteur humain incarné. Le corps résiste au pouvoir du numérique.

La recherche neuroscientifique actualise les théories esthétiques de la perception de l'espace qui remontent au 19<sup>e</sup> siècle. Ces théories attribuant le rôle central au corps ont été informées par les enchevêtrements avec l'étude scientifique de la perception humaine, en psychophysique ou en psychologie expérimentale. Les théories formulées par les disciplines scientifiques ont été adoptées par l'esthétique où elles ont persisté jusqu'à ce qu'elles aient prouvé tout leur potentiel dans les médias numériques.

*Key words: Incarnation, neurosciences cognitives, réalité virtuelle, agence corporelle*

## Contemporary narratives of the body and the digital

We are faced with narratives presenting the digital as a threat to the embodiment. Popular culture often addresses the transition of ever more aspects of human lives into the digital realm as a sort of disembodiment. The body seems to be helpless or superfluous in a realm of digital imagery. We conceive of the digital as if the body was excluded from it or worse, as if it had had to submit to the absolute power of the digital. Thus, the body is seen as a vulnerable object that can be subject to theft, novel ways of abuse,<sup>1</sup> segregation, exclusion, or control<sup>2</sup> as presented by sci-fi literature and cinema. Questions about what happens with the body, once the consciousness is acting within a virtual realm or issues concerning the access to such realms are often answered by dystopian visions. These are based on erroneous perspectives on the relation between a body and a self. Cognitive neuroscience studying the relation by summoning out-of-body illusions in augmented or virtual reality is offering another vantage on the problematics.

## Scientific perspectives on the resistance of virtual embodiment

The experiment known as the rubber hand illusion (Botvinick, Cohen, 1998) tested the basic mechanisms in summoning out-of-body illusions within the neuroscientific study of the relations between a self and embodiment. In this experiment the subject's hand is hidden from their sight, while they see a rubber model of a hand in a position similar to the real hand. The experimenter is stroking both hands synchronously for a given duration of two or more minutes. At the conclusion of the tactile stimulation, the subjects disown their biological hand and establish a feeling of ownership towards the rubber one. In the early versions of the experiment, the illusion was verified by the so-called threatening stimulus. The rubber hand was threatened by a conventional dangerous object (such as a knife, a fork or a hammer). If the subject showed a protective reaction, the researchers would conclude that the illusion was summoned successfully. The procedures (except the threatening stimulus) have been used with modifications in the experiments analyzed in this paper.

In augmented or virtual reality, such illusions are not limited to specific body parts. Entire bodies can be replaced.<sup>3</sup> Within the experiments, subjects are wearing a virtual reality headset. The headset hides their biological bodies from view, while the display is rendering a virtual body. The experimenter is stroking the subject's biological body and the virtual one synchronously. The brain is, thus, exposed to

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<sup>1</sup> Leckie, A, 2013, *Ancillary Justice*, London, Orbit Books.

<sup>2</sup> Leino, P, 2022, *Nebe*, Brno, Větrné mlýny.

<sup>3</sup> Slater, M. et al., 1 November 2012, "The Sense of Embodiment in Virtual Reality", in: *Presence: Teleoperators and Virtual Environments*; 21, 4, p. 373–387. doi: [https://doi.org/10.1162/PRES\\_a\\_00124](https://doi.org/10.1162/PRES_a_00124)

conflicting information coming from various senses. The subjects feel the touch they see on the virtual body. In as little as 2 minutes, they disown their biological bodies and transfer their perceived embodiment into the body rendered on the display. In order to acquire a deeper understanding of the relations between the body and the self, neuroscientists are designing various speculative bodies and studying whether and under what conditions these can be accepted as the subjects' bodies. The speculative body images include body like objects,<sup>4</sup> empty space as an invisible body,<sup>5</sup> multiple bodies simultaneously,<sup>6</sup> or body swapping between two subjects, while the illusion is not disrupted when they shake hands.<sup>7</sup>

The neuroscientific research suggests the persisting role of embodiment in virtual spaces. Experiments have successfully staged out-of-body illusions where the subjects transferred their perceived embodiment into bodies with different skin colors, ages, genders and other visible particularities of individual bodies without any problems. We could, therefore, be asking what it is that persists in the body. It is neither the gender, nor the skin color, the age or any other of its specificities. What resists any kind of challenge posed by the digital transition is the concept of the body. It is the idea of an embodied perceiver, of a subject that navigates through a space. The space itself is projected by the very subject. What resists erasure is the body. Resistance, in its literal meaning, is a word precisely describing the perception within the experiments. The body, the perceived embodiment stands back and again at its place. It always returns.

### **Spatial disruption from sensory models of space in Aesthetic perspective**

The illusions staged by neuroscientists work with the distinction between haptic and optical perception. In the aesthetic discourse the distinction was fundamental in the line of thought on spatial perception founded by Alois Riegl.<sup>8</sup> The Austrian art historian has theorized “*tactile*” perception as the one through which we can perceive the immediate surroundings. Through this kind of perception we can, however,

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<sup>4</sup> Petkova, V. I., Ehrsson, H. H., December 3, 2008., “If I Were You: Perceptual Illusion of Body Swapping”, in *PLoS ONE* 3, 12: e3832. <https://doi.org/10.1371/journal.pone.0003832>

<sup>5</sup> Guterstam A., et al., April 23, 2015, “Illusory ownership of an invisible body reduces autonomic and subjective social anxiety responses”, in *Scientific Reports* 5, 9831, p.2., <https://doi.org/10.1038/srep09831>

<sup>6</sup> Heydrich, L. et al., December 18, 2013, “Visual capture and the experience of having two bodies – evidence from two different virtual reality techniques”, in *Front. Psychol.*, 4, 946, <https://doi.org/10.3389/fpsyg.2013.00946>

<sup>7</sup> Petkova, V. I., Ehrsson, H. H., December 3, 2008., “If I Were You: Perceptual Illusion of Body Swapping”, in *PLoS ONE* 3, 12: e3832. <https://doi.org/10.1371/journal.pone.0003832>

<sup>8</sup> Riegl, A., *Late Roman Art Industry*. Rome: Giorgio Bretschneider Editore, Eng. trans. by R. Winkers 1985. [*Die spätromische Kunst-Industrie*, Vienna, Verlag der Kaiserlich-Königlichen Hof- und Staatsdruckerei, 1901].

grasp only the surfaces in our physical reach. What would be perceived as their background through the sense of sight is lost in tactile perception. “*Optical*” perception, on the other hand, unites objects in one environment. Within optical perception we can speak of grasping a space and not only individual isolated objects as if they were placed in a vacuum.

Riegl’s theory offers an interesting perspective on the experiments. Within the experiments the separation between the “*Nachsichtig*” zone where haptic perception takes place and the “*Fernsichtig*” zone accessible only to optical perception is broken down. The perceived embodiment merges the two into one sensorium without strict divisions.

Soon after Riegl, Walter Benjamin<sup>9</sup> reconsidered the division in the context of cinema. While preserving the distinction, Benjamin emphasized that “*tactile*” perception was a matter of habit. This kind of perception did not require a lot of attention. On the contrary, “*optical*” perception asks for contemplation of the seen, for careful attention. The procedures applied in neuroscience experiments need to disrupt space in relation to the body in order to generate new spatial organizations enabling new models of embodiment. Benjamin theorizes optical perception as a mode prone to transformation in thinking, resistance to habitual thinking, to theories we accept without questioning. That is what happens in the experiments where the subjects transfer their perceived embodiment into virtual bodies - sight prevails over other sensory stimuli and leads to novel percepts and novel knowledge. Such perception resists habitual thinking.

### **The agency of virtual bodies**

Moreover, neuroscience research suggests that perceived embodiment in virtual realms has the ability to condition the virtual space independently of its code. Some of the experiments are revealing specific glitches in the way space functions, is organized or behaves following the transfer of perceived embodiment into a virtual body. These aspects of the out-of-body illusions staged in laboratories are often overlooked. However, in the following lines we will be unmasking traces of virtual embodiment’s impact on virtual space recorded by neuroscientists. We will, therefore, examine three specific experiments within which we can scrutinize three different ways in which virtual bodies inform virtual space independently of the code.

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<sup>9</sup> Benjamin, W. “The Work of Art in the Age of Its Technical Reproducibility”, in *The Work of Art in the Age of Its Technical Reproducibility and Other Writings on Media*. eds. Jennigs M. W. et al., Eng. trans. by Jephcott, E. et al., Cambridge and London, The Belknap Press of Harvard University Press, 2008, p. 19-55. [Benjamin, W., 1936, “Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit”, in *Zeitschrift für Sozialforschung*. 5, 1, p. 40–66.]

Among the examples of research transferring the perceived embodiment of subjects into virtual bodies, we could find experiments conducted at Ehrsson Lab at Karolinska Institutet, in Stockholm, Sweden, where the subjects' perceived embodiment was transferred into body models of various sizes.<sup>10</sup> This experiment will be the first one re-enacted and analyzed in this paper. The researchers' initial interest was concerning the impact of the scaled body on the subjects' mental body representation. They were therefore offering the subjects a shrunken body model (40 cm long) and an enlarged body model (400 cm long) towards which they were establishing a feeling of ownership. The results showed that the scale of the body had no negative consequences on the out-of-body illusion. The virtual bodies were accepted as if their scale was not modified. The findings of the experiments reveal that the subjects did not perceive their virtual bodies as out-of-scale. Their experience suggests that the bodies were perceived as having a human scale, whether they were 40 or 400 cm long. On the contrary, the space appeared to be changing its scale although no modification to it was done in the course of the experiments. The perception of the space was adapting to the bodies. If the perceived embodiment of the subject was transferred into a smaller body, they perceived the space as enlarged and vice versa, from a larger body, the space appeared shrunken. The body became an invariable base for any spatial percept. The characteristics of the body served as basic metrics for spatial perception which adapted to the body and not vice versa. Through various measurements, the scientists were aiming at understanding the magnitude of the perceived embodiment's scale on spatial relations. The body was, thus, resisting any modification and deforming the perceived space accordingly.

Further research has proven the relation between the scale of the virtual body and the one of the virtual space.<sup>11</sup> The critical re-enactments of neuroscience experiments were eliminating other elements that could impact the perception of the virtual space. The virtual body was placed in a dark “*nonspace*,”<sup>12</sup> a black background without any inherent spatial quality. It could be a dark space just as well as it could be a flat black surface. Only the presence of the body transforms the ocean of black pixels into a space.

We could say that the body is in control of the virtual space. The body is, thus, not excluded from it, nor does it have to submit to the virtual. It is endowed with

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<sup>10</sup> Van Der Hoort, B., et al., 2011, “Being a Barbie: The Size of One's Own Body Determines the Perceived Size of the World”, *PLoS ONE*, 6, 5.

<sup>11</sup> Masarik, J.E., 2024, *Vnímání virtuálního priestoru*, Bratislava, Slovak University of Technology in Bratislava.

<sup>12</sup> In this context nonspace does not make reference to Augé's non-places but rather to the way the architectural historian Anthony Vidler addresses cyberspace as a metaphor for data without any inherent spatial quality.

a “*constitutive singularity*.”<sup>13</sup> The body informs virtual space independently of its code. Such perspective reverses the traditional narratives of the embodiment and the virtual and puts the body in the position of power.

According to the media theoretician Peter Weibel,<sup>14</sup> it is necessary to distinguish between the digital and the virtual. The digital is the code, a datascape, a nonspace. It is a data collection without any inherent spatial quality, it is ungraspable by human perception. This applies particularly to virtual reality, where we only get a two-dimensional image for each eye. This image is merely a rendering of the digital code. Neither of them, neither the code nor the flat image are spaces. The term digital space is merely a metaphor through which we are able to conceive of the “*unthinkable (or rather the unthinkable within the frame of modernism) conditions of life without space, of the spaceless, or of the absolute ‘void.*”<sup>15</sup> The idea still resonates in contemporary media theory. Trevor Paglen writes about digital imagery as about something that “*has become detached from human eyes and has largely become invisible.*”<sup>16</sup>

The virtual<sup>17</sup> in Weibel’s theory is a sensory realm. It is a rendering, an embodied alternative to the digital. The virtual relies on active human perception, human understanding of the imagery and the way the human perceiver determines what imagery is rendered on the interface. This is well illustrated by the functioning of virtual reality, where the user decides by their movement, position and orientation in space what imagery is rendered in the head-mounted display. At the same time, the user is actively composing a three-dimensional space out of two two-dimensional images. The process of creating a space does not rely merely on the digital code or its renderings. It is equally a result of an embodied cognitive and creative activity of the perceiver. The virtual is, thus, defined and conditioned by embodied human per-

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<sup>13</sup> Hansen, M. B.N., 2004, *New Philosophy for New Media*. Cambridge, London: The MIT Press, p.11.

<sup>14</sup> Weibel, P., 1999, “Virtual Worlds: The Emperor’s New Bodies.” in *Ars Electronica: Facing the Future. A Survey of Two Decades*. ed. Ars Electronica Center. Druckerey, T. 1999., Cambridge, MA, MIT Press, p.207-223.

<sup>15</sup> Vidler, A., 2000, *Warped Space: Art, Architecture, and Anxiety in Modern Culture.*, Cambridge and London, The MIT Press. p.233-234

<sup>16</sup> Paglen, T. “Invisible Images: Your Pictures Are Looking at You.” in: *Architectural Design* 89, 1.p. 22-27 <https://doi.org/10.1002/ad.2383>

<sup>17</sup> The virtual in this context is not the virtual which alternates the actual, as theorized by philosophers such as Bergson, Deleuze etc. Weibel’s conception of the term does not refer to the virtual/actual dichotomy. He uses the term to nuance the term used to describe the polyvalent concepts conventionally included in the word “digital.” Through the new terminology he addresses the lack of terms taking into consideration the ramifications of the concept of the digital and the ignorance of differences between the code and the sensory perception of its outcomes.



Fig. 1. Photo documentation of the re-enactments of the scaled embodiment experiment. The image depicts the strokes on the foot - the haptic stimulation - conducted during the experiment.

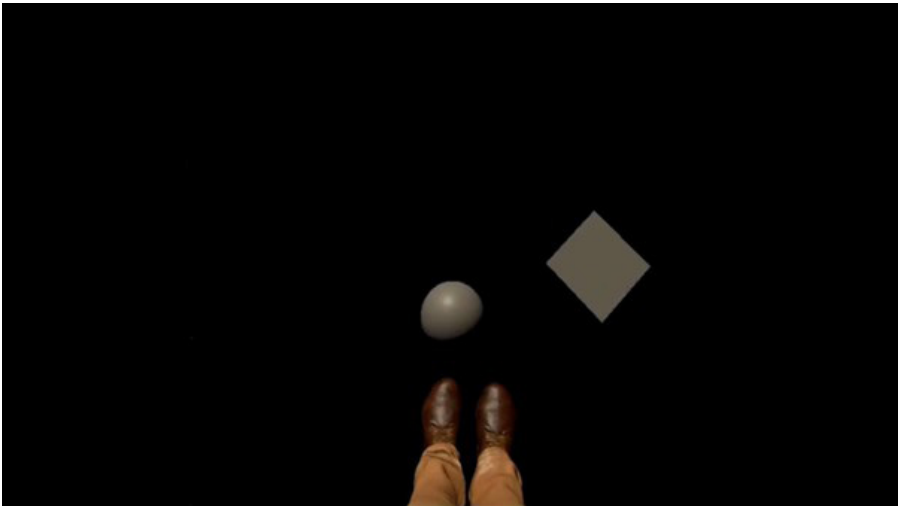


Fig. 2. The image is a still from the imagery rendered in the head-mounted display during the stimulation in the framework of the re-enactment. It shows a shrunken body with the ball touching it.



ception. In this perspective, the body makes space in the event of an encounter with a nonspace. It is, therefore, necessary to study it through human senses. Therefore, as opposed to the digital, the virtual has spatial qualities, otherwise it would be impossible to grasp through human senses. In this way the perception of virtual spaces is equally their forming. The way virtual spaces are perceived is defining their qualities. We could say that the perceived scaling of virtual spaces within the experiments equals their actual scaling in Weibel's conception. Such perspective emphasizes the agency of perceived virtual embodiment to act independently of the code, to resist the absolute power of the digital.

The second experiment analyzed was equally conducted at Karolinska Institutet. The procedure was similar, however, instead of transferring the perceived embodiment into bodies of different sizes, it was transferred into an invisible body.<sup>18</sup> The subjects did not see any body in the VR headsets. They only saw an object moving in the empty space. Once it reached an area that could be occupied by their body, the subjects felt a touch. The researchers were focused on the possibility of establishing a feeling of ownership of an invisible body and its implications. They were, therefore, trying to understand the perceived invisible body in terms of its position, orientation or shape. While trying to explain the cognitive procedure, they were finding support in optical research working with invisibility. Within the research referenced by neuroscientists, opticians created surfaces of layered glass capturing light beams, leading them along the layers and then releasing them as if their trajectory had not changed.<sup>19</sup> Therefore, if an object was placed inside these surfaces, it could not be seen. However, anything behind the area defined by the surfaces was seen as there was nothing standing between it and the perceiver. Following this logic, we can conclude that the virtual body seen on the headset's display is bending the virtual space just as the layered glass. The fold in the virtual space has the shape, position and orientation of the virtual body studied by neuroscientists. Such deformation of the virtual space is not resulting from its code. It is purely a result of the perceived virtual embodiment. Such deformed space can no longer be theorized as a Euclidean space with three straight axes. A novel space depending merely on the perceived embodiment and its qualities is being defined. In this case the perceived virtual embodiment claims its power further than in mere scaling. It splits from the experience known from physical space and establishes a novel space fitting its needs in virtual conditions.

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<sup>18</sup> Guterstam A., et al., April 23, 2015, "Illusory ownership of an invisible body reduces autonomic and subjective social anxiety responses", in *Scientific Reports* 5, 9831, p.2., <https://doi.org/10.1038/srep09831>

<sup>19</sup> Chen, H. et al., June 7, 2013, "Natural Light Cloaking for Aquatic and Terrestrial Creatures", in *arXiv.org* e-print 1306.1780. <https://doi.org/10.48550/arXiv.1306.1780>



Fig. 3. Photo documentation of the re-enactment of the invisible embodiment experiment. The image depicts the stroking of the hip - the haptic stimulation - conducted during the experiment.

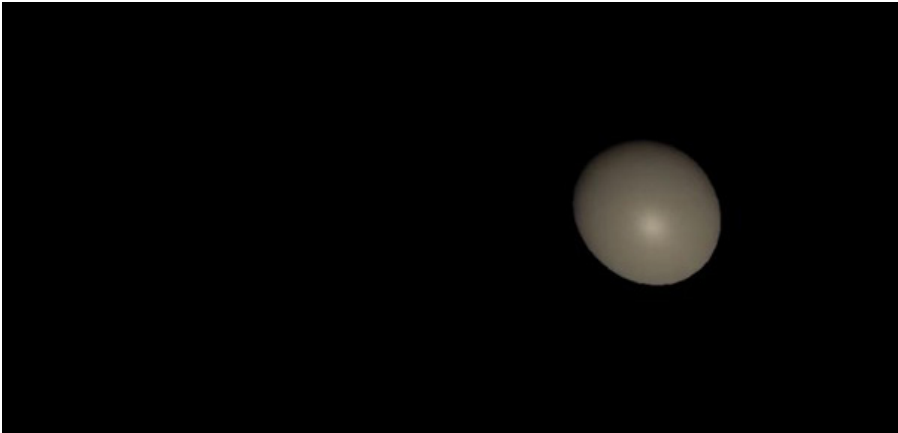


Fig. 4. The image is a still from the imagery rendered in the head-mounted display during the stimulation in the framework of the re-enactments. It shows the ball touching an invisible body.

In the last experiment studied in this section, the subjects' perceived embodiment was transferred into a body seen from a third person perspective.<sup>20</sup> The researchers were scrutinizing the impact breaking the life-long experience of seeing one's own body from the first-person perspective will have on the illusion. The subjects were feeling the touches they saw on a body standing 2 meters in front of them on their own bodies. After the tactile stimulation was finished, the subjects were displaced and asked to go to the position where they felt their presence during the experiment. The findings show that the subjects were indicating positions leaning towards the body seen in front of them. Neuroscientists are speaking of an "embodiment drift". Subjects indicate that even if they were not fully immersed in the illusion of embodiment in the body seen from the third person perspective, they felt that the object touching them had impact on them.

We can, therefore conclude that novel relations between two points in the space defined by the virtual embodiment are being established, the distance between them disappears in the experience of the subjects. The point from which the subjects see the body and the point where the virtual body is located are connected. What happens in one of them is equally happening in the other one regardless of their perceived distance. The perceived embodiment blurred in the framework of this experiment proves its role of establishing spatial relations within the virtual space that escape the logics of Euclidean space. If in the previous experiment the space was folded, in the present one, these folds are bridged in novel ways. One point occupies two co-

<sup>20</sup> Lenggenhager, B. et al., August 24, 2007, "Video Ergo Sum: Manipulating Bodily Self-Consciousness", in *Science*. 317, 5841, 1096-1099. DOI: 10.1126/science.1143439

ordinates synchronously. The distance between them is null, although they appear to be far apart. To reach the other point, one does not need to undergo a gradual change of coordinates until their values meet. Without being located in two coordinates, without splitting their presence or position, the subjects are present in both points. We can, therefore, conclude that the perceived embodiment has the agency to define virtual spaces regardless of the code or any other logics known from other spatial experience.



Fig. 5. Photo documentation of the re-enactment of the third-person perspective embodiment experiment. The image depicts the stroking of the shoulder - the haptic stimulation - conducted during the experiment.



Fig. 6. The image is a still from the imagery rendered in the head-mounted display during the stimulation in the framework of the re-enactments. It shows the virtual body seen from a third person perspective and the ball touching its shoulder.

### Remarks on the term “virtual”

We have been dealing with the virtual following a conception suggested by the media theorist Peter Weibel. This conception defines the virtual as an embodied version, graspable through human senses of the digital which is pure data designed for machine vision.<sup>21</sup> In the following section, we will be trying to put the research in relation with historical and contemporary thought on spatial perception and the perceiver’s body. Therefore, another version of the term virtual would be introduced. The subject of this research is the Weibelian virtual, however, the thought on the embodiment and its role in spatial perception implies other conceptions.

The virtual evoked in the following section is based on Henri Bergson’s conception of the real and the virtual. The Bergsonian virtual<sup>22</sup> is inscribed in a longer philosophical and scientific tradition, which is both predating the philosopher and also continued in the subsequent evolution of philosophical thought. Bergson’s concept would be further explained in the following section.

It is important to bear in mind the difference between the two concepts covered by the term “virtual”. Although the two virtuals - the one issued from Bergson’s thought and the one issued from Weibel’s - show signs of similarities in certain

<sup>21</sup> Weibel, Peter. *Virtual Worlds: The Emperor’s New Bodies*. p.207-223 in *Ars Electronica: Facing the Future. A Survey of Two Decades*. ed. Ars Electronica Center. Druckerey, T. 1999., Cambridge, MA, MIT Press, p.221.

<sup>22</sup> Bergson, H., 1939, *Matière et mémoire: Essai sur la relation du corps à l’esprit*. Paris, Presses Universitaires de France. p.32.

points, they are different. To respect the different conceptions of the virtual and to keep the arguments clear, we will have to update the terminology. The text would be distinguishing between the two by designating Bergson's conception of the virtual by the Bergsonian virtual and Weibel's by the Weibelian virtual.

### **Models of space based on bodily agency**

From its encounters with research in neuroscience and its predecessors such as psychophysics in the 19th century, philosophy has been formulating theories based on scientific knowledge of perception. Psychophysics was studying and quantifying<sup>23</sup> the body's perceptual abilities, the stimuli and their transformations into percepts.<sup>24</sup> The body has, thus, become the cornerstone of perception studies. In response, the re-thinking of the body and space in the context of the knowledge generated by cognitive neuroscience and its predecessors, required novel theories on the body and space in the field of philosophy. The body was not a passive receiver of information coming from outside. It was an active agent in the perception process.

The French philosopher, Henri Bergson, made a division of space similar to Riegl's. The difference did not consist in theorizing zones defined by their accessibility to various senses, but by its accessibility to the body in general.<sup>25</sup> Bergson, therefore, defined the zone of "real actions" by which he meant the area in the direct reach of the body, a zone where the body could really make an action. Beyond it, there is the zone of "virtual actions", where the interactions could not be realized in the given spatial setup. From the actions within the zone of real actions we pass into perception which replaces actions in the zone of the virtual ones. Perception becomes an extension of action. The body, and its position, in this conception define the space, frame it, decide which parts are acted upon and which ones are perceived. For the body itself Bergson specifies a different mode of perception he calls "affections". It is a way of sensing the body from inside. On the surface of the body, on the skin, "affections" and actions meet. The virtuality or realness of actions in Bergson's terms is a way to differentiate specific aspects of the perceiver's ability to act upon the surrounding space. The virtual evoked here is not identical with the Weibelian one. Both the zone of virtual actions and the zone of real actions could be contained in a Weibelian virtual space.

The central role of the body in framing and shaping the space is visible in the

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<sup>23</sup> Crary, J., 1990, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century*. London and Cambridge, The MIT Press, 1990. p.147.

<sup>24</sup> Valiaho, P., 2010, *Mapping the Moving Image: Gesture, Thought and Cinema Circa 1900*. Amsterdam, Amsterdam University Press. p.54.

<sup>25</sup> Bergson, H., 1939, *Matière et mémoire: Essai sur la relation du corps à l'esprit*. Paris, Presses Universitaires de France. p.32.

way Bergson theorizes the body. In his ideas formulated in *Matter and Memory*, Bergson defines all matter as a collection of images. The body as a material object is equally an object. This image is, however, different from other images. While non-bodily images interact with one another automatically following natural laws, the body has the ability to decide whether or not it reacts to action coming from other images. Bodies, therefore, introduce indetermination into interactions between images, between material objects. The body frames the images, it decides which images enter the frame and which ones remain outside its borders. In this way Bergson's thinking foresees some of the ability of the body to shape virtual<sup>26</sup> space manifested in the framework of neuroscience experiments discussed in this paper. However, in the experiments, the body proves its ability to shape virtual space globally. The body's agency does not depend on its relative distance from specific zones of the space. Bergson's theory of embodied framing of percepts, however, seems to manifest its full potential in VR technology and its contemporary use. It is the body, its position, orientation, the gaze of the VR headset user that defines the images rendered by the head-mounted display.

Insisting on the connection of space with time, Bergson claims that it is impossible to study movement merely as a trajectory, as a line extracted from time. Without time there is no movement. Bergson goes even further saying space is not a condition preceding movement, but it is the other way round. Movement precedes space, movement lays space underneath it. A perceiving subject thus frames and defines the space through their movement. That is what is happening in the last experiment, where the subjects' perceived embodiment moves from their habitual position, where it claims a new position defined by the body seen in front of them. Bergson's reflection, although using the notion of virtuality, was not taking into consideration Weibelian virtual spaces. However, even in Bergson's writings we can see a sort of resistance of the body towards spatial apriori. The body is endowed with its enframing abilities defining spatial percepts. In this point the Bergsonian and Weibelian virtual spaces converge - both depend, although in various measures, on the active embodied framing.

Although Bergson's writings were published in times when film was not new, and it is also important to remember that he was active in France where its development was going fast in the period, the philosopher was avoiding it in his texts as much as possible. It was Gilles Deleuze who brought the concepts into dialogue with

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<sup>26</sup> Here "virtual" refers to the alternative to the digital as defined by Weibel, not an alternative to the actual as theorized by Bergson.

film and made necessary adjustments within the theories.<sup>27</sup>

Deleuze insists on the connection between the image (“*living*” or non-living) and movement. He extends the image as far as its actions can reach. The images, and thus also bodies, are, therefore, not limited to their physical extent anymore. They start merging with space. Bodies are in constant movement and interaction with other images. Deleuze distinguishes interactions between non-living images, where the things fully reveal themselves and interaction with living images, where perception enframes information, bits of it remain outside the frame. Things themselves are called “*movement-image*” in Deleuze’s terminology. Once an image movement enters in interaction with a “*living image*”, information is enframed and the image becomes a “*perception-image*”. Afterwards, the living image can create a reaction, in such a moment, the “*living image*” is not framing information anymore. What is happening is the bending of the space. Bergson’s distinction between the zone of “*real*” and “*virtual actions*” breaks down. The “*virtual actions*” and reactions can be realized, they become “*real*”. In this case Deleuze speaks about “*action-images*”. If the body decides not to emit a reaction, the action is absorbed, in that case we speak of “*affection-images*”.

“*Action-images*” deforming the space and turning the Bergsonian “*virtual actions*” into “*real*” are a surprisingly fitting formulation of the procedures through which perceived virtual (in Weibelian terms) embodiment exercises its power over the Weibelian virtual space. Once the body creates a reaction to stimuli, the space is being modified. The Weibelian virtual space claims its nature as a sensory realm directly dependent on human perception.

The French architect Bernard Cache defines architecture as the art of the frame.<sup>28</sup> Similarly to previous theories, Cache develops a theory of image. His theory identifies three elements constituting the image: points of inflection, vectors and a frame. The “*points of inflection*” are an apriori, they exist independently of the image. These points need to be connected by “*vectors*”, which come with human action. Vectors define mutual relations between points of inflection and establish a topography. The vectors are not predefined, various variations are possible, they bring indetermination in the space. The “*frame*” then defines an interval within the space. Its contents are difficult to predict, but architecture works with frames of probability. It manipulates the frame in order to obtain the desired results. In Cache’s conception the “*body*” is defined as a disruption of predictable conditions within the frame. The body disrupts the usual functioning of vectors. And that is what is happening in the

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<sup>27</sup> Deleuze, G., 1983, *Cinéma 1: L’Image mouvement*. Paris, Les Editions de Minuit.

<sup>28</sup> Cache, B., 1995, *Earth Moves: The Furnishing of Territories*. Cambridge and London, The MIT Press, p.3.



neuroscience experiments. The rendering of the digital in the head-mounted display offers the “*points of inflection*”, a basis for the subsequent construction of a Weibelian virtual space. The construction itself corresponds to the determination of “*vectors*”. The setting is then “*framed*” by the perceiver. Their embodied presence introduces disruptions and unpredictability. The body disrupts the predictable functioning of space in order to claim its position. By resisting the Euclidean space it generates a new one. Cache’s writings being published in 1997, the architect had an insight into digital prototyping and the issues concerning digital spaces or objects. His reflection is not considering the embodiment in the way neuroscience experiments are. The publication of the book predates Botvinick’s and Cohen’s rubber hand experiment publication (1998). However, Cache’s theory of framing as an architectural practice and the concept of the body as a spatial disruption offer solid foundations for an aesthetic reflection of the originally neuroscientific experiments. The formulation of the concepts is relatively vague, yet it inspired the thinking of media theoreticians.

The media theoretician Mark B. N. Hansen positions his perspective on new media among Bergson’s, Deleuze’s and Cache’s theories. He defines digital images as those where the body takes on the role of the framer.<sup>29</sup> He underlines that digital media are not forms but rather interfaces rendering data. It is the body in interaction with the interface that decides what and how is to be rendered. The framing function is not on the interface but on the body. Virtual space is the perfect embodiment of such a perspective on digital media. The digital data, the datascape have no spatial quality. It is through filtration of information that a space is created. According to Hansen’s theory, this process takes part in the body.

Such perspective is informed by Weibel’s distinction between the digital and the virtual. Therefore, Hansen accords the body the autonomy to define virtual spaces independently of the datascape of the code. And allows the body to shape the virtual realms as an autonomous tool in interaction with digital interfaces. That is the case in the experiments discussed above.

## Conclusion

Some of the scientific theories on perception dating back to the 19th century have vanished from scientific thinking. They have, however, informed aesthetic theories which have evolved into current media theory. Through these theories the knowledge is reunited with contemporary neuroscience research. Some of the questions theoreticians of digital media are asking are shared by neuroscientists who are trying to understand the links between embodiment and the self in physical and virtu-

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<sup>29</sup> Hansen, M. B.N., 2004, *New Philosophy for New Media*. Cambridge, London: The MIT Press, p.22.

al spaces. The knowledge generated by their research is updating aesthetic thinking, similarly to the way it did in the 19th century.

What persists throughout the evolution of thought in both fields is the role of the body. The transition of the research and thought into the Weibelian virtual has not diminished the role or power of the body. On the contrary, the results of the re-enactments of neuroscientific experiments show that in the Weibelian virtual the embodiment has fully proven its abilities, previously suggested only in theory. The body resists alleged threats of the virtual and writes its own narratives. The experiments themselves reveal the body's agency to act autonomously beyond the framework of the digital code, beyond the Weibelian digital.

The illusions summoned in the experiments are deeply rooted in sensory, and therefore, embodied experience. Such embodiment oscillates between the physical and Weibelian virtual space. In this sense, the actual physical body is a condition for presence in Weibelian virtual realms. We can, therefore, conclude that the Weibelian virtual space is only possible with a body. The body is oscillating between the actual and the Weibelian virtual in order to provide exchanges between the two realms. Although the nature and functioning of such virtual space is independent of those of the actual one, its constitution would be impossible without the body's oscillations.

The body does not submit to the Weibelian virtual space. The space's existence is fully dependent on the body. Such perspective opposes the dystopian science-fiction narratives, where one's consciousness can be "downloaded" and "uploaded" into a virtual realm. The paradoxical fictions are based on forgetting the central role of the body. Presupposing various sorts of bodily augmentation or oppression, are based on the dualism between a body and a self. Such a perspective, however, ignores the findings of the original neuroscience research. Neither the embodiment studied in the framework of the original experiments nor the Weibelian virtual bodies used in the re-enactments are not threatening or canceling the physical body. These bodies are extensions of the biological bodies themselves. The Weibelian virtual body is a way through which the body leaks into Weibelian virtual realms and claims its agency in them. The fluidity of the body allowing its transference into the Weibelian virtual through virtual bodies endows it with the ability to inform virtual spaces independently of their code. The dimensions, bends, and spatial relations can be fully controlled by the perceived Weibelian virtual embodiment. Such bodies resist the code's absolute power.

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