Truth in media art through sensory-motor coordination

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PRESENTATION

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Abstract

While most of the debate surrounding the notion of truth focuses on its nature (dealing with the question whether truth is objective or subjective), ultimately, the foundation for establishing any kind of truth lies in our perception. In this presentation, I will step aside from debates concerning the nature of truth in media art, and instead focus on its perceptual foundation by answering the question: *When do we perceive something as 'real' in media art?* Focusing on relatively recent theories on perception, I argue that we perceive media artworks as 'real' when they take into account, i.e. make good use of, the principle of sensory-motor coordination. I will first briefly explain the principle of sensory-motor coordination and how it constitutes perception. Secondly, based on examples from the artistic Research and Development practice, I will argue that media artworks that make better use of this principle provide more realistic and, hence, more truthful experiences. Thirdly, I will strengthen this claim by showing that artworks developed on the basis of the principle of sensory-motor coordination can result in completely new and truthful experiences. Fourthly, I show that ideas for intriguing media art projects that use insight into sensory-motor coordination to create true experiences are abundant, and form strong indicators of the potential of such insight in the media art context. Additionally, I will show that this insight is already being applied in the media systems that are currently beginning to shape our everyday use of media. Concluding, I state that new media artworks that ignore the principles of sensory-motor coordination may never establish a truth beyond the 'representational truth' of the 'old' media, while media artworks that do take into account this principle are likely to provide experiences that are much nearer to how the real world is experienced, i.e. to reality. Therefore, this presentation advocates using insights into sensory-motor coordination to advance new media's interactive qualities towards truth in media art.

1 When do we perceive something as 'real' in media art?

Although most of the debate surrounding the notion of truth focuses on its nature (dealing with the question whether truth is objective or subjective), ultimately, the foundation for establishing any kind of truth lies in our perception. Therefore, in this presentation, I will step aside from debates concerning the nature of truth, and instead focus on its perceptual foundation. I will approach the central question of this session - *Is there truth in media art?* - by answering the question: *When do we perceive something as 'real' in media art?* In order to answer the latter question I will begin this presentation by briefly introducing the principle of *sensory-motor coordination*, which explains how reality is perceived (and hence, *truth* is perceived) in our daily lives. Following this short theoretical introduction, I will briefly describe several examples of artistic Research and Development (aRt&D). On the basis of these examples, I will discuss how media artworks that make good use of the principle of sensory-motor coordination can provide a much stronger sense of reality, and hence, a stronger experienced truth, than those that do not make use of the principle of sensory-motor coordination. In the final part of this presentation I advocate advancing new media's interactive qualities, to allow interaction based on sensory-motor coordination, in order to achieve truth in the media arts.

2 Sensory-motor coordination

Sensory-motor coordination has been intensively researched in recent years, and it would be impossible to adequately discuss the existing body of research in its full scope here. However, using an illustrative example I will try to explain the overall mechanism and its fundamental claims.

Theory on sensory-motor coordination states that perception (and more broadly, intelligence) emerges from interaction with the environment; we make sense of the world around us by exploiting the consistencies in the perceptual changes that result from our own physical actions. I will clarify this by means of an example discussed by Kevin O'Regan and Alva Noë in their groundbreaking paper *'A sensorimotor account of vision and visual consciousness'[7].* See Figure 1.

Let's presume that the eye in Figure 1 (top right) is one of your eyes. You move your eye's focus upward a little as indicated in the figure; from fixating your eye on a straight line, to fixating it at the space just above that straight line (top left). Since the light-sensitive cells on the back of your eye (that make up your eye's retina) are positioned on the curved inner surface of your eye, the focal shift of your eye will result in a change of retinal stimulation from a great arc on the equator of the eye (if we would flatten our retinas this would form a straight line, hence the straight line in the 2D depiction of the retinal stimulation in Figure 1) to a different, smaller great arc above it (bottom left). (The colored triangles and black dots represent color sensitive and light sensitive cells on the retina.) The stimulation of neurons in our brain, here labeled the 'cortical representation' (bottom right), changes accordingly.

After looking at this figure, the obvious question is one that has puzzled many psychologists and philosophers in the past: *Why don't we perceive a bent line after moving our eye's focus upwards?* The answer to this question illustrates the most important and fundamental principle of sensory-motor coordination: We (still) perceive a straight line when moving our eye's fixation as in the Figure, *because* the motor action - the upward motion of our eyes - results in the change in stimulation of our retina into a smaller great arc above our eye's equator. If we had moved our eye sideways, then this change would not have occurred (in fact, in that case, no change would have occurred). And if the line would not have been straight but curved instead, then this relation between our eye's movement and the resulting sensory change would have been completely different, hence we would not have experienced 'straightness'. Always when we move our eyes over a straight line in a certain way, it consistently results in this typical sensory change, i.e., the change in sensory information is *invariant* to the movement of our eyes. Such invariant relations between our motor behaviour and their resulting sensory changes are moreover referred to as *sensory-motor contingencies.* In this case we could say that we exploit this sensory-motor contingency to experience straightness.

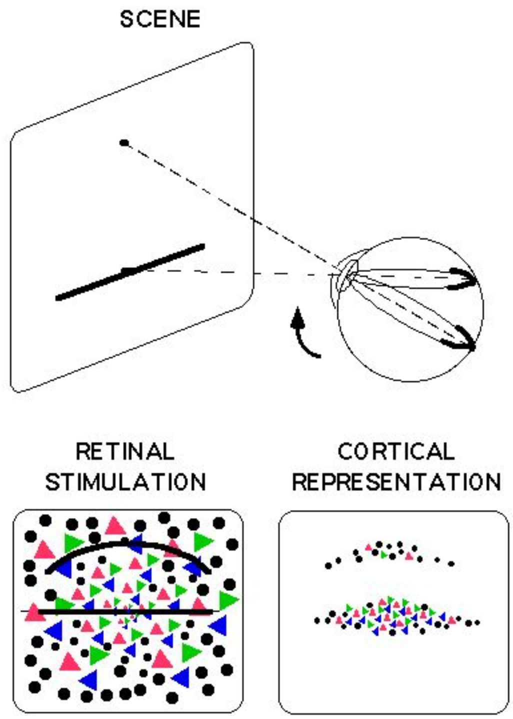

Figure 1: "The eye fixates the middle of a straight line and then moves to a point above the line. The retinal stimulation moves from a great arc on the equator of the eye to a different, smaller great arc. [...] If the eye moves along the straight line instead of upwards, there would be virtually no change at all in the cortical representation. [...] This is the idea underlying the theory that shape in the world can be sensed by the laws obeyed by sensorimotor contingencies." [7, p. 941]

To emphasise the brilliance of this approach to perception, I would like to contrast it shortly with the explanation offered by classic mainstream psychology. In classic psychology, perception is believed to work through the use of a large database of symbols stored in our brains, and every time a sensory pattern occurs, the pattern is compared to the symbols stored. In this line of thought we perceive straight lines by finding a match between the sensory stimulus on our retinas and the symbol for 'straight line' stored in our brains. However, as we have just seen in the example above, when we move our eyes up and down over a straight line, the sensory pattern on our retina changes drastically and poses the 'problem' stated before: *Why don't we perceive a bent line after moving our eye's focus upwards?*

While we have just seen how this change in sensory stimulation is of fundamental use to perception as explained by sensory-motor coordination, a common answer provided by classic psychology would be that our brain *compensates* for our body's movements (see, e.g., [6]). In this line of reasoning, the cortical representation occurring after our eye's movement in Figure 1 has to be transformed back into the cortical representation that occurs when looking straight at the line, by some higher region in our brain, in order to allow a match between the retinal stimulation with the 'straight line symbol' stored in our brain.

If this explanation doesn't already strikes one as inefficient, philosophical and scientific objection against the explanation offered by classic mainstream psychology are abundant. For instance, a compensatory mechanism is yet to be found in the brain, it is unclear how a symbol activated by a match with a sensory pattern is eventually interpreted by our cognitive systems (the infamous *homunculus problem*), and, since the eyes do not only shift occasionally but are in constant jittery movement, the processing required to compensate for that movement would be so enormous that it is very unlikely that our brains have the computational power to do so.

Furthermore, there exists empirical evidence that provides an even stronger critique regarding such 'symbolic' approaches to perception; while one would expect that perfect fixation of an eye would make an ideal circumstance to match incoming sensory patterns to symbols stored in our brain, it was shown that when an observer's eyes are perfectly fixated, i.e., completely refrained from movement, the observer cannot see anything at all! To the sensory-motor coordination approach described above, this eye fixation effect is logical, since perfect fixation of the eyes takes the action out of the sensory-motor loop that our perception requires to exploit the sensory-motor contingencies in the interaction with the world.

Understanding the mechanism of sensory-motor coordination is important in the context of this session on 'truth in media art' because, as stated in the introduction, the foundation for establishing any kind of truth lies in our perception. Thus, a better understanding of how we perceive in general is likely to lead to a better understanding of how truth is experienced in media art. In the following section of this presentation, I will show how insights into the principle of sensory-motor coordination, such as just discussed, can be applied to make media art experiences more realistic.

3 Artistic Research and Development

I will first discuss two aRt&D examples that deal with Virtual Reality (VR) and Augmented Reality (AR), as the field of VR and AR has seen particularly illustrative developments in interactive systems that allow users to exploit sensory-motor contingencies in the interaction with the system. Subsequently, I will discuss two relevant aRt&D examples form other fields of research.

3.1 Virtual Reality and Augmented Reality

By contrasting the VR art installation *DEVMAP* with the AR art installation *Exercise in Immersion 4*, I would first like to illustrate how technological advances in VR and AR user experiences advance the realism of those experiences by making better use of the principle of sensory motor coordination.

3.1.1 DEVMAP

DEVMAP was developed by the artist collective *Workspace Unlimited* and was commissioned by V2_Institute for the Unstable Media for the Dutch Electronic Art festival in 2004. The VR installation of *DEVMAP* and its users' interaction with the installation are typical for many VR artworks: a user stands in front of a screen that is placed a few meters away from him or her and controls the movement (walking) of an avatar in a projected virtual world by moving a mouse (walking direction) and by pressing the left or right mouse buttons (forward or backward walking respectively). The structure of the *DEVMAP* virtual world is made up of data (audio, video, and/or text) which can be streamed live into the virtual world (as was done during the Dutch Electronic Art Festival 2004, see Figure 2).

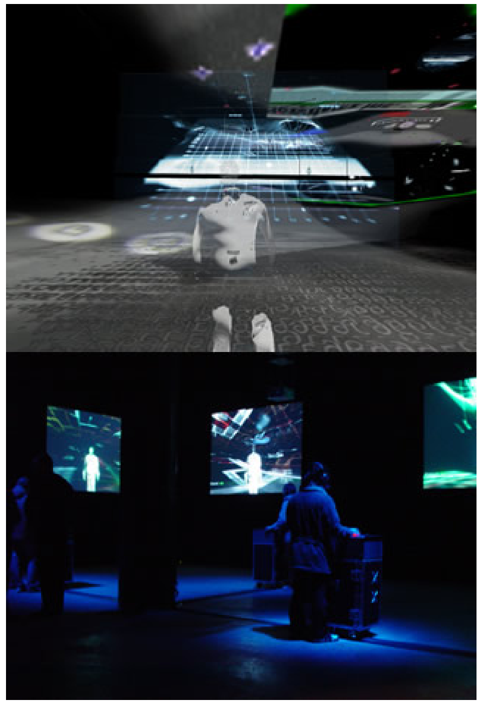

Figure 2: *DEVMAP* by Workspace Unlimited. Top: A still showing a data landscape of live fed media. Bottom: Users explore the *DEVMAP* virtual world as avatars from the installation's consoles.

Upon a user's first interaction with the *DEVMAP* virtual world, navigation through the environment feels more like scrolling through a text document than like walking through a landscape. However, the sensation of reality experienced while interacting with the *DEVMAP* virtual world grows on a user after a period of actively engaging with the VR environment. Despite this growing sense of reality, even after longer periods of interaction with the *DEVMAP* virtual world, the experienced sensation is still not very comparable to the sense of reality experienced in the real world. The reason for this is that the *only* sensory-motor relations that can be explored for new or existing contingencies is limited to our finger movement and the resulting changes on the screen in front of us. The sensory-motor contingencies that can be found through such limited interaction are very small, and very different from the contingencies we exploit on an everyday basis. Moreover, the interaction that we have with the virtual world competes with the integration that the rest of our body has with the real world.

In general, the sense of reality experienced in a VR installation (and AR installation, as we will see in the next example) will always be limited to the invariants that occur in the sensory-motor interaction that the installation allows for. Since the interaction in a set-up such as *DEVMAP*'s is very limited (and because within that limited interaction it is not even sure if any invariants occur) the experienced sense of reality in the virtual world will always be poor. Hence, the experienced *truth* in a VR installation such as *DEVMAP* will also be slight.

Figure 3: *Exercise in Immersion 4* by Marnix de Nijs and V2_Lab. Left: The common reality is modelled in a 3D model. Right: Simulated elements, called *bionts*, overlay the common reality.

3.1.2 Exercise in Immersion 4

The Augmented Reality of *Exercise in Immersion 4* (*EI4*) is a spectacular artistic endeavor into the partial overlaying of real surroundings with simulated elements. The *EI4* art-game was first demonstrated as a prototype at the Dutch Electronic Art Festival 2007, where a deserted storage building was used as the real surrounding to overlay with simulated elements (see Figure 2).

In *EI4*, a player wears a specially designed headset-display and a crash-suit. The headset has a sensor system that connects the position of a player with previously modeled visuals. A player starts the game in common reality (see Figure 3, left), but as he/she progresses in the game the common reality is increasingly taken over by visually simulated elements. The goal of the game is to collect *bionts*, small virtual balls that float around in the air (see Figure 3, right). The collected *bionts* gather in front of the player, and bounce off real and virtual obstacles. When enough *bionts* are collected, the player progresses a level in the game. With every subsequent level, the player is more exposed to a virtual world. At later stages in the game, the virtual world even completely occludes the real world, and real-world obstacles are no longer visible to the player. At this stage of the game, the *bionts* serve as a navigational aid, avoiding crashing into obstacles like walls and pillars in the real world.

Upon entering the *EI4* augmented game world, it is almost immediately clear that such an AR environment provides a much stronger sense of reality than, for instance, the VR environment of *DEVMAP*. The straightforward answer to why this is the case is technological in nature; the 3D engine and the immersive projection technology used in the installation provide a more realistic experience. Although such AR technology indeed *provides* stronger realism in a user experience, it can only do so because the technology allows for many sensory-motor invariants in the user-system interaction, and hence allows exploiting sensory-motor contingencies, either learned anew or those that users are familiar with from the common reality. Admittedly, VR installations could also be advanced in this direction by projection through *Head Mounted Displays* or *Cave*-like environments, but they will never feature the main advantage that AR has over VR; which is that most of the sensory-motor contingencies that users are familiar with from the real world are retained, because the real world itself is used as a background to the new reality, with only new sensory-motor relations occurring for the overlaying simulated elements. Therefore, as long as the surroundings are only partially overlaid with simulated elements, the sense of reality in AR artworks is stronger than that of VR artworks.

The main problem with AR, however, is that the sense of reality in AR artworks strongly depends on the level of synchronization of the simulated elements with the real world. If the overlay of the simulated elements runs asynchronous with the real world, then the invariants that the user relies on to make sense of the reality become variant (i.e., the consistencies in sensory change as a result of moving one's senses are gone), in which case the sense of reality for the simulated elements is almost immediately lost. Synchronisation of the simulated elements with the real world also poses the main technical challenge of AR, since in order to do so the movement of a user needs to be very precisely tracked. (A more thorough comparison between VR and AR in terms of sensory-motor coordination can be found in [4]).

Augmented Reality installations are not the only field in which the exploitation of more sensory-motor contingencies provides more realistic, and hence truthful, experiences for the user. Many examples can also, for example, be found in force-feedback systems research (see, e.g., [3]).

Regarding the VR and AR, theory on sensory-motor coordination can explain how AR provides a much stronger sense of reality than VR does: In short, AR does so by allowing the exploitation of sensory-motor contingencies that occur in the real world, as well as by including invariants in the sensory-motor relations in the interaction between a user and the system.

VR systems could be said to also have advanced to AR systems without this insight into the underlying mechanism of sensory-motor coordination, which could suggests that the theory merely explains why AR provides stronger senses of reality than VR does. There are examples of aRt&D however, in which insight into sensory-motor coordination not only explains the experiential effects of the artwork, but also played an essential role in its development, such as in the case of *The Enactive Torch*.

3.2 The Enactive Torch

The Enactive Torch (see Figure 4), developed by Tom Froese and Adam Spiers at the *University of Sussex*, is a small hand-held device equipped with an ultrasonic sensor and a small vibrator. Not only does it consist of only two relatively basic components, its inner mechanism is also not very complex; the output of the ultrasonic sensor is merely changed into a motor signal that drives the small vibrator.

Figure 4: *The Enactive Torch* developed by Tom Froese and Adam Spiers.

Despite the torch's relatively simple construction and inner mechanism, the device is capable of conveying the somewhat awkward, but convincing, experience of 'seeing' with one's hands ('scanning' one's surroundings with it, and moving it like one would a paintbrush). This experience, a phenomenon moreover referred to as *haptic vision*, is simply achieved by producing vibrations when *The Enactive Torch*'s ultrasonic beam hits an object or person in its surrounding, with the intensity of the vibration correlating to the distance from the object or person in a 1 to 1 mapping. This perfect correlation allows invariants to exist in the perceptual change (vibration) and moving the device through space. By doing so, it allows for the exploitation of sensory-motor contingencies, and, consequently, the experience of 'seeing' spatial properties in one's surroundings through vibration on the skin, as one normally would through light sensitive cells in one's eyes.

Figure 5: Sensory substitution device for haptic vision by Bach-y-Rita (Image taken from [1]).

Although *The Enactive Torch* was inspired by the research of Bach-y-Rita [1], who experimented with haptic vision by translating contours in video images (received through small cameras attached to glasses) into vibrations on the skin (see Figure 5), *The Enactive Torch* draws heavily on theory on sensory-motor coordination [5] and would probably not have been developed without that insight.

On the basis of *The Enactive Torch*'s successful application of theory on sensory-motor coordination - allowing the exploitation of sensory-motor contingencies to create a completely new and 'true' experience - we may conclude that at least one way to achieve truth in media art, is to develop applications that allow invariants to exist in our sensory-motor interaction with the medium.

3.3 Image Fixation

In order to show the potential of insight into sensory-motor coordination for the future of aRt&D I would like to propose an intriguing potential media art project that uses insight into sensory-motor coordination to create a '*true* act of disappearance'.

In the section on sensory-motor coordination, I stated that it has been empirically proven that when someone's eyes are completely refrained from movement, i.e. fixated, this person cannot see anything at all, because the fixation of the eyes takes the action out of the sensory-motor loop that constitutes our perception. In theory, the reverse should also be true; when one would move an image in perfect correlation to the movement of a person's eyes, this image should be invisible to that person. I will name this method 'image fixation'.

The project that I would like to propose is to develop an installation in which one person's eye-movements are tracked while a projector project's images on a screen at positions that perfectly correlation to the movement of this person's eyes. When tracking and projection follow each other perfectly, and in a speed that is very close to real-time, the projections will be visible to anyone except for the person whose eye-movements are tracked.

This experience of blindness is a *true* perception, in contrast to attempts to deceive a user's perception, as is common in magic tricks for instance, which is why I just claimed that this proposal creates a '*true* act of disappearance'. Besides 'image fixation', several other proposals to achieve such true and new experiences, by allowing the exploitation of sensory-motor contingencies, have been proposed in the work of Susanne Blackmore [2].

Since aRt&D is a continuous search for new experiences, and striving towards *true* experiences, I believe that there is a strong artistic value in researching projects such as that proposed here. Although projects such as 'image fixation' are technically very challenging, and may not be realised for years from now, I do regard them as strong indicators of the potential for insight in the mechanism of sensory-motor coordination for media art.

3.4 PointScreen

While both *The Enactive Torch* and the proposed *Image Fixation* project are very strong indicators of the potential that insight in the mechanism of sensory-motor coordination may have for the future of media art, several recent aRt&D examples show that this mechanism is *already* being applied in the new media systems that are currently beginning to shape our everyday use of media. An illustrative example in case is the *PointScreen* technology that was developed by Wolfgang Strauss, Monika Fleischmann, and their team at the MARS Exploratory Media Lab of the Fraunhofer Institute for Intelligent Analysis and Information Systems. *PointScreen* is an interface technology that allows a user to manipulate digital artefacts without touch, but rather through enhanced human body energy. The technology found its first implementation in the project *Info-Jukebox*, a gesture based digital multimedia kiosk system, in 2003. See Figure 6.

Figure 6: *Info-Jukebox* by Wolfgang Strauss, Monika Fleischmann, and their team at the MARS Exploratory Media Lab

Since then, the *PointScreen* technology has seen many more applications in the aRt&D projects by the MARS Exploratory Media Lab, such as the astonishing 'touchless' interfaces *Matrix Browser,* in which *PointScreen* technology is applied for browsing the student projects submitted to "Digital Sparks" 2001 - 2006, and *Interactive Poster*, in which *PointScreen* technology is applied to create a public-space information terminal. Both projects are depicted in Figure 7.

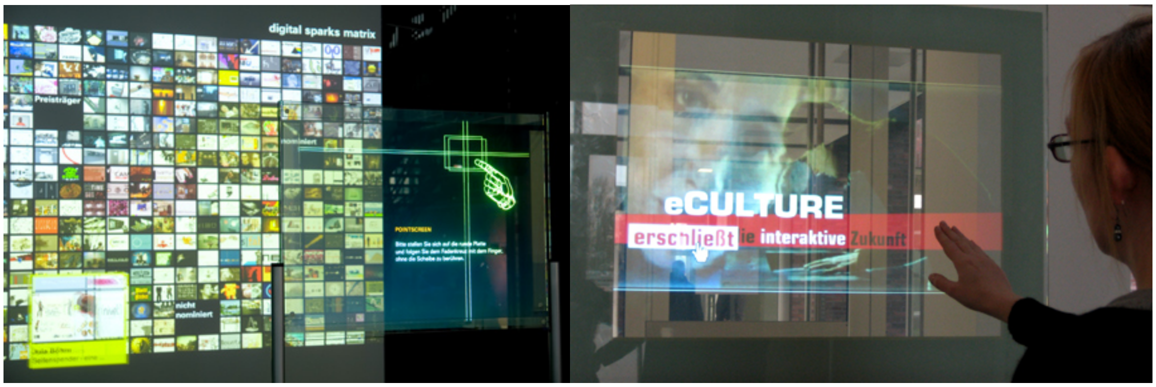

Figure 7: *Matrix Browser* (left) and *Interactive Poster* (right) by Wolfgang Strauss, Monika Fleischmann, and their team at the MARS Exploratory Media Lab

Pointscreen technology draws heavily on the research of Lev Theremin, whom in the early years of the 20th century developed one of the first electronic music instruments; the 'theramin'. The theramine is also the first example of what is nowadays known as 'Electric Field Sensing' (EFS). Basically, EFS measures changes in an electro magnetic field caused, for instance, by the human hand. In *Pointscreen* technology this principle is cleverly used to interface between a user and a computer: moving a hand in front of the EFS sensor changes the electro magnetic field and from these changes the movement of the hand can be deduced, to in turn manipulate the media depicted on a screen.

Instead of going further into technical detail on *Pointscreen* technology, I would like to discuss the *experiences* that the implementations of this technology in the projects of the MARS Exploratory Media Lab convey. Regarding the experience of their work *Info-Jukebox,* Strauss *et al.* state that 'Previous versions of EFS-based interfaces required the user to calibrate the system, which is no longer necessary in our advanced version installed in the Jukebox. Here, interaction takes place in a natural and *invisible* way by enhancing the energy field around the user's body. The interface is self-descriptive, it does not need instructions for use since moving one's body in front of the device results in visible feedback on the screen.' Going back to the insight into sensory-motor coordination, we can now easily explain why the 'interaction takes place in a natural' way: In contrast to more common computer interfaces (such a mouse or keyboard) this type of interface allows the exploitation of sensory-motor contingencies. As in the real world, an almost infinite amount of invariant relations exist between the required hand movements and the resulting visual change perceived. Furthermore, users can generalise contingencies from those that we are already familiar with in the real world, since the relation between motor movement and resulting sensory change are quite similar to those occurring, for instance, when waving flies away from a fruit bowl. Again, as was also stated in the *EI4* example, the technology *provides* the strong realism, but it can only do so because the technology allows for many sensory-motor invariants in the user-system interaction.

The projects developed by the MARS Exploratory Media Lab introduced here show that insight into the mechanism of sensory-motor coordination is already being applied in the new media systems that are currently beginning to shape our everyday use of media, and support the argument that insight into this mechanism has potential for the future of media art.

4 Towards truth in media art

In the preceding sections of this presentation I have 1) briefly explained the principle of sensory-motor coordination and how it constitutes perception; 2) argued that media artworks that make better use of this principle provide more realistic, and hence *truthful*, experiences; 3) illustrated how artworks developed on the basis of the principle of sensory-motor coordination may result in completely new and truthful experience; 4) shown that ideas for intriguing new media art projects that use insight into sensory-motor coordination to create *true* experiences are abundant, and form strong indicators of the potential of such insight in the media art context; and 5) revealed that this insight is already being applied in the new media systems that are currently beginning to shape our everyday use of media.

While my third and fourth points are meant to show the potential of insight into sensory-motor coordination for aRt&D and the fifth shows that this insight is already having its effect, the first and second point form the core message of this presentation, as they answer the question posed in the introduction: *When do we perceive something as real in new media art?* We perceive media artworks as 'real' when they take into account the principle of sensory-motor coordination, by allowing a user to exploit sensory-motor contingencies in the interaction with the artwork. Such artworks are experienced as 'real' because we perceive them exactly as we perceive our everyday world. New media art that ignores this principle can be very convincing, but may never establish a truth beyond the 'representational truth' of the 'old' media. In other words, when a media application does not allow the exploitation of sensory-motor contingencies in interaction with the application, the experience will always feel as a manipulation of *a representation of* the truth instead of as reality itself.[1]

In the light of these concluding remarks, I would like to advocate using these insights into sensory-motor coordination to advance new media's interactive qualities to allow users to exploit sensory-motor contingencies in interaction with the medium in order to achieve truth in media art.

References

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[1] This conclusion also reveals a deeply rooted relationship between the two main pillars of this symposium *Space* and *Truth*. Media art that makes good use of the principle of sensory-motor coordination in interaction with the surrounding physical *space* ultimately results in experienced *truth*.

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