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# How can you believe it?
# A proposal of characterization of the notion of believability in mediated interactions with artificial and distant environments

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## Introduction

The present paper aims at providing a proposal of characterization of the notion of believability which is suitable for mediated interactions with artificial or distant environments.

At present different notions have been introduced and discussed that aim at capturing the main qualities of mediated interactions. In the domain of virtual reality and teleoperation the most diffuse are the notions of 'presence'[1], 'immersion'[2], 'realism'[3],

[1] The notion of 'presence' in particular has been presented as *the* crucial notion for describing and testing the peculiarity of the interaction in mediated conditions and many tests have been proposed in order to measure the feeling of 'being there' in terms of a psychological state or experience of self-location (Slater, 2000), of an attentional state (Witmer & Singer, 1988) or as a perceptual illusion of non mediation (Lombard & Ditton, 1997). A different notion of 'presence', characterized as the experience that an object is present even if only a part of it is directly sensed, has been developed by experiences with the real world (Noe, 2003).

[2] The notion of 'immersion' has been characterized as the psychological experience of being included and interacting with an environment; according to this characterization, the association of immersion and involvement (the psychological experience when focusing attention on a set of stimuli) produces a sense of presence (Witmer & Singer, 1988). A different approach to the notion of 'immersion' has been proposed by

'user's efficiency'[4]; a number of tests has been developed by different virtual reality laboratories in order to evaluate the performances of the interaction, the user's capacities of identification, the action fidelity of the user of virtual reality devices in rapport to non-mediated interactions, the usability, comfort and suitability of the device, the efficiency and the psychophysical reactions of the user during different tasks. Each test responds to different aims, ranging from the intention of producing more performing devices for different tasks to the desire of better understanding the human reactions to different virtual environments.

As a matter of fact, 'the mediated interaction with artificial and distant environments' is an umbrella term which includes a great variety of applications, technologies and aims. The will for a unique concept runs the risk of hiding the different needs and aims and realities of the domain of the mediated interactions with virtual and distant environments. It is certainly important to analyze and highlight the existence of connections between the different notions. A protocol of indications about which of the notions and which of the test is more suitable in any different condition of application, technological equipment, aim, is strongly needed.

The characterization of the notion of believability which I propose here is thus not aimed at substituting the notions of 'presence', 'immersion', etc. The notion of believability captures only some of the aspects of the interaction and is suitable only for some of the applications, the technologies and the aims that engineers and computer scientists.

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(Slater, 2000), according to whom immersion is a characteristic of the technology employed to produce presence and essentially regards the number of senses which are stimulated by the medium.

[3] The term 'photorealism' is the name of an artistic movement of the late 1960's; photorealistic artists painted their scenes in a style closely resembling photographs, the goal being to accurately reconstruct a still object or scene. The term has been adopted by early computer graphics for indicating the goal of accurately reproducing the geometry and light reflection properties of surfaces. There are anyway many varieties of realism, including "dynamic" realism, in which the relevant components of environment that must be realistically reproduced are the behavior of animated characters, of natural phenomena and of the physical conditions of the environment. Another form of realism is named 'action fidelity' and consists in the accurate perception of resemblance between simulator and simulated, that is, in how closely the simulated situation resembles the real situation in terms of the characteristics of the performed action (

[4] Tantamount to successfully supported action in the environment (Zahoric & Jenison, 1998)

**Characterization of the notion of 'believability'. A proposal**

Our normal experience of the world is normally believable, except for some quite bizarre circumstances.

When we look at a waterfall for some time and successively turn our attention to the rocks which are close to the waterfall we have the visual experience of the rocks moving upwards. We can hardly believe that the rocks are really moving against gravity[5]. The same condition of non-believability has been described for the experience, provoked in laboratory conditions by the vibration of muscles, of one's own limb moving behind the anatomic limits of the joints[6]. The sense of bizarreness and impossibility that can arise in response to these experiences is related to a sense of wrongness: we can hardly believe our senses, something must be wrong in what we experience[7]. In these situations, we have the tendency to suspend our faith in the truth and objectivity of our experience. We are not necessarily able to identify the wrong component in our experience, we just feel that it cannot be so. A common reaction to unbelievable experiences (and to the discovery of errors in general) is represented by the reaction of surprise[8].

The situations that arouse this particular sensation are thus significant for better understanding which factors influence our faith (or our doubt) in the believability of certain perceptual circumstances.

Another trivial element of our experience of the world consists in the fact that none of us would be disposed to describe his experience in terms of visual sensations, associated with tactile feelings, etc.; our perceptual judgments regard the existence of a certain object at a certain place at a certain time. Let us imagine of waking up one morning with a great variety of sensations, but without being capable of identifying any known object, anything as an object, even unknown and even any stable, localizable, trackable pattern of stimulation. How could we believe something?

[5] Addams, 1834
[6] Craske, 1977; Goodwin, McCloskey & Matthews, 1972
[7] Bruner & Postman, 1949
[8] Davidson, 1982

If perception was to inform us only about our local sensations, we could not consider perception as a form of experience of the world. We can focus our attention on local sensations, but is about distal objects that perception normally informs us. If perception didn't offer some form of stability, some possibility of identification and of recognition we could hardly have something to believe.

Although the characterization of our normal experience is worthy of a deeper and a more rigorous discussion, I take inspiration from the examples I have cited for proposing the following characterization of the notion of 'believability': *believability is the condition which is realized when a certain pattern of stimulation is experienced as an object and as objective (or true)*.

Given the characterization of the notion of 'believability' I have proposed, a first step in the direction of the clarification of the concept and in the search for pragmatic indications is constituted by the review of some studies dedicated to the notion of 'object' and the notion of 'objectivity'.

**Experiences with objects**

Some studies in object perception suggest two considerations about our experiences with objects.

1. The experience of a pattern of stimulation as an object is not necessarily coincident with the experience of a pattern of stimulation as "that object". Thus, the *experience of an object* is not necessarily committed with the *recognition* of the object as a particular object or with the *identification* of all the properties of the experienced object. As a matter of fact, we often perceive objects that we do not know and we perceive them as objects, even if we are not capable to recognize them. We do not experience new objects as proximal, unstructured stimulations only because we are not familiar with them.

In the domain of experimental studies on adult perception, (Kahneman & Treisman, 1984) and (Pylyshyn, 2001) have suggested that even before they perceive the qualities or features of objects, adult human beings experience objectual entities called 'proto-objects' because no quality is assigned to them yet. Evidence for such an hypothesis is constituted by the capacity adult human beings show of tracking moving entities without being able, on the other side, to ascertain their properties[9].

On the other side, recognition does not seem to represent a sufficient condition for perceiving a pattern of stimulation as an object. It is shown by some experiments on biologic motion[10] that observers tend to recognize a human being in movement when exposed with some moving light points. Although in certain circumstances a group of moving light points can be recognized as a human being in movement (that is, the pattern of stimulation can be matched to an object which is known by the observer), moving light points would not necessarily be considered as an object.

2. The experience of an object consists in something more than the pattern of stimulation and in something less than a complete pattern of stimulation. A cat behind a fence is still perceived as a cat, and not as: a slice of cat, a stick of wood, a slice of cat, a piece of wood, etc.: even if we do not really see the entire cat, we still make the visual experience of a cat. Hence, we do not need a complete pattern of stimulation (of a cat) in order to perceive a complete object (a complete cat). Nevertheless we

[9] (Kahneman & Treisman, 1984) decline proto-objects as temporary object files. The suggest that attention can be directed on *temporary object files* that contain information regarding features such as color, shape, localization, etc. Objects can then be perceived and visually tracked even if they are not identified as objects of a specific type.

(Pylyshyn, 2001) argues for the existence of a mechanism (*visual indexing*) that can index one or more proto-objects: the index draws the attention on something object-like (extended in space, with boundaries) that is in a certain position of the visual field, even without taking into account other characteristics such as color or shape. The object is then conceived as a sort of candy floss: the pseudo-object is the stick around which the different features condense.

[10] Johansson, 1973

need something more. In fact, how things appear not only depends on how they are: it also depends on the relations of the perceiver to how things are. This fact is particularly apparent for some of the properties of the perceptual content, such as the property of a round object of appearing elliptical when seen from a certain position. Furthermore, we keep track of the changes our movements provoke on the appearance of the objects, such as when we move our eyes, and this fact has a relevant place in the perceptual experience of the objects. Both these are perspectival aspects of the perceptual content that are only partly determined by how things are.

*The parsing of perceived stimuli into objects*

Elisabeth Spelke has dedicated a large attention to the study of infant's object perception[11]. Infant perception indicates, according to (Spelke, 1990, 1991) that object perception can be considered as composed of three, hierarchically ordered processes or of three forms of representation: first, the child forms a representation of the superficial appearance of a stimulus; then the perceived stimulus is parsed into objects; finally, the objects are recognized as specific, familiar objects. Spelke concentrates her attention on the constitution of representations of the second level, that is, on the perception of units that are not yet recognized as familiar objects but that are nevertheless identified as objects. The transition from the first to the second level of representation is granted, according to (Spelke, 1990, 1991), by the presence of some characteristics in the stimulus situation: cohesion, connection, rigidity and no action at distance.

*The constitution of multisensory objects*

The criteria suggested by (Spelke, 1990, 1991) for the constitution of perceptual objects are valid for unisensory perception. The growing quality of multisensory devices in the domain of computer-mediated interactions suggests the necessity of individuating additional criteria that are valid at the multisensory level. Which are the factors involved

[11] see for instance, Spelke, 1990, 1991

in the constitution of perceptual units in presence of multisensory stimulation? A pattern of visual stimulation can show cohesion, connection, rigidity and no action at distance and a pattern of haptic stimulation too; but in which conditions will the visual and the haptic pattern be perceived as one and the same unitary object (independently of the fact of recognizing it as a particular object)? Many and different answers have been advanced for solving the so-called 'binding problem'[12].

An interesting direction of studies indirectly connected with the binding problem is dedicated to intersensory conflicts, influences and discrepancies. By proposing two or more discrepant multisensory stimuli it is possible to individuate the conditions (both internal and external) under which the resultant partial percepts are combined in one and the same unit (perception of one, multisensory object) or parted to constitute two different units (perception of two, unisensory objects). Additionally, the study of intersensory conflicts gives indications about the different aspects multisensory percepts can take depending on the external and internal conditions[13]. The different role played by the measure of the discrepancy, the sensory modalities involved, the cognitive and environmental factors (that can influence the assumption of unity), the perceptual task, the presence of active exploration, etc. deserve further empirical investigation[14].

One thing seems to be ascertained: the propensity on the side of the perceptual system to maintain coherence between intersensory stimuli, even in presence of discrepancies.

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[12] Roskies, 1999. The problem of how different perceived features (eventually intersensory features) are bound in a unitary percept only arises when it is supposed that the different features (the intersensory information) are separately extracted so that they have to be combined successively. Some authors deny that the binding of different features constitutes a problem for the perceptual system because a global, multisensory array is directly perceived (Stoffregen & Bardy, 2001). Within this approach the sensory modalities are hardly differenced. The sensorimotor approach to perception (O'Regan & Noe, 2001) affirms that a multisensory experience is produced by the simultaneity of exploratory actions with multiple sensory modalities. Within this approach each sensory modality is defined by a specific set of laws connecting current/possible behaviors and their sensory consequences, that is by a specific set of sensorimotor contingencies.

[13] Rock & Victor, 1964; Heller, Calcaterra, Green & Brown, 1999; Lederman, Thorne & Jones, 1986; Lederman & Abbott, 1981; Ernst & Banks, 2002; Ellis, Flanagan & Lederman, 1999; Ernst & Buelthoff, 2004

[14] (Welch & Warren, 1981)

So, the resulting unitary multisensory percept undergoes some modification and no conflict is normally explicitly perceived[15].

*The constitution of complete, distal objects*

(O'Regan & Noe, 2001) strongly affirm the role of the exploratory actions and movements of the perceiver in the constitution of the perceptual content. As an ability of exploration, perception does not happen instantaneously, but develops in time. This is the reason why, according to the authors, even if the perceiver does not see all the details of a scene simultaneously, they can be present for him (be part of his perceptual experience) as details that one has the possibility of discovering during the scan of the image. Touching a part of the object is making the experience of the object as a whole because a simple shift of the hand allows the perceiver to enter in contact with the other parts of the object. The other parts are thus present to the perceiver as the necessary consequences of possible exploratory actions, given a certain group of sensorimotor contingencies.

The perceptual sense of presence of an object as a whole arises because the parts that are presently unsensed are nevertheless within reach, in ways that are known by the perceiver (Noe, Forthcoming).

The possibility of actively moving the sensory organs that are responsible for one specific sensation seems to be responsible of another important characteristic of object perception: the distality of the sensed object. A stimulus in fact can be perceived both as a subjective, proximal, local sensation or as the sensation of the external, distal object which causes the experience. This bipolarity is particularly perspicuous in the touch modality. Both (Katz, 1969) and (Gibson, 1962, 1966) call the attention on the fact that when the stimulation is passive, as when the hand of the subject is being touched by an object, even if the object is moving, the subject obtains sensations of skin modification; it is only when the subject plays an active role by actively touching the object that attention is directed to the properties of the object.

[15] (Stein & Meredith, 1993; Welch & Warren, 1981)

More recently, the experiments of Bach-y-Rita[16] with sensory substitution systems have shown that the objectifying role of movement can be extended to vision too. Systems for touch-vision substitution are developed with the aim of making it possible for blind people to perceive visual features of the environment. They are constituted of three main components: a device for image capture, a device for transducing the light energy into a form of energy which is compatible with the tactile system and a device for providing tactile stimuli to the perceiver. Tactile stimuli can be applied at different locations to the skin of the perceiver. In this way the optic information is transmitted to the tactile receptors. Stimulations are sensed as local when the perceiver is not allowed to freely move and orient the optic device in order to actively explore the environment. It seems on the contrary, that when active exploration is allowed, the information is projected to the external world and many judgments that are typical of visual perception, such as the appreciation of perspective and depth, can be performed.

*Pragmatic indications from the studies on object perception*

Both the studies on object perception in children and the studies on intersensory conflicts provide pragmatic indications for the production of patterns of stimulations that can be perceived as complex, multisensory objects in mediated conditions.

It is suggested that the characteristics of cohesion, connection, rigidity and no action at distance should be respected for a pattern of stimulation to be perceived as an object, even if it is not recognized as a previously known object.

Tests for believability will not need to be based on the recognition of features or objects of the real world the user is familiar with (as it is the case for tests for realism and identification tests).

It is also suggested that the reactions of the user of multisensory devices to discrepancies between different sources of information should be tested; the result of the tests will give indications about the capacity of the user to construct unitary percepts in different conditions of mediated experience and about its tolerance to the lack of

[16] (Bach-y-Rita, 1982)

coherence between multisensory stimuli (in consideration of the capacity of the perceptual system to compose certain discrepancies into unitary, coherent percepts).

The non necessity of recognition and of familiarity with real objects marks the difference between believability and realism, in the sense of the photorealistic reproduction of the aspect of objects of the real world. The realism which is associated to believable experiences regards the structural conditions of normal perception, not the content of normal perception. These conditions include factors that are relative to the stimulus situation (such as cohesion, connection, rigidity, no action at distance) and factors that are relative to the user's attributes (such as the possibility of moving and structuring sensorimotor contingencies).

Studies on the role of movement in perception as those conducted by (O'Regan & Noe, 2001) are in fact suggestive of the necessity of taking into account the specific connections that are created between action and perceptual response to action in mediated experiences. When the sensorimotor contingencies that are structured in normal perception cannot be respected in virtue of the limitations or of the characteristics of the interface, the possibility of developing new, *ad hoc* sensorimotor contingencies should be favored and tested. Examples of constitution of new sensorimotor contingencies have been produced by sensory substitution systems and have demonstrated to be able to produce a sense of objectuality or distality of the perceived object[17].

**Objective experiences**

Two other considerations can be added to the remarks about the experience with objects which regard the objective character of the most part of our perceptual experiences. As I have said before, perception is not bound to inform us about our local sensations but about the world of distal objects.

[17] Bach-y-Rita, 1982

3. To experience a pattern of stimulation as objective means that the stimulus is experienced as non-subjective, in the sense that it does not depend on the activity of the subject.

   It seems possible for a subject to judge of the objectivity of a pattern of stimulation on the basis of some characteristics of the experience, such as the re-identification of a pattern of stimulation as the same pattern of stimulation previously experienced. (Strawson, 1959) suggests that an experience is objective when it does not depend upon the actions of the individual; thus an objective entity continues to exist even when it is not perceived. (Strawson, 1959) thus equates objectivity with *unperceived existence*.

4. To experience a pattern of stimulation as objective or non-subjective also means that the experience is intersubjective, that is, that multiple subjects in the same conditions would share the same experience. (Davidson, 1982, 1984) indicates in the concept of intersubjectivity the meaning of objectivity as independency from beliefs.

*Objective experiences can be re-identified*

(Strawson, 1959) defines objectivity as the property that allows the justified distinction between the experience of the subject and the object of the experience. In Strawson's opinion, re-identification (the possibility of re-identifying the object as the same object that has been perceived before the interruption of the perceptual experience) is the relevant criterion for objectivity. An event that exists even when it is not experienced by a perceiver can in fact be re-identified after an interruption in the experience.

Strawson's definition of objectivity includes the reference to spatial concepts in that only a spatially organized experience allows re-identification: an object or event can be re-identified as being the same only if it occupies the same spatial coordinated before and after the interruption of perception.

The possibility of re-identifying an object or an event of an artificial or distant environment which is perceived through computer media could be used as a test for objectivity, hence be included in a test for believability.

At the opposite of a recognition or of an identification test, a *re-identification test* is not committed with realism. One can re-identify a virtual object after it has disappeared from perception without matching it with a real object. The virtual object needs not to be a copy of a real one.

*Objective experiences are intersubjectively valid*

According to Davison, objectivity and truth depend on a condition that he names 'triangulation', which is constituted by two linguistic subjects and by the world. The world has a causal role, while only the presence of two subjects mutually interpreting their utterances about the world can give rise to thoughts, beliefs and other propositional attitudes. Two individuals in sight of one other both seeing a lion see each other hiding; they correlate what they see with the other's reaction. After repeated expositions to the same situation, when one of the two individuals sees the other hiding, even if he doesn't see the lion, he is apt to treat the situation as one with a lion, and to hide; in the same conditions the idea of error could also arise, if for instance each of the individuals sees the same lion, but one, because of external conditions, reacts as in front of a gazelle.

Objectivity thus requires a condition of intersubjectivity and the exposition of two or more interacting, linguistic individuals to one and the same world.

Following this concept, two or more subjects that share the same experience with a virtual environment could be conducted to form the same beliefs about the objects of the experience and to consider the experience as objective, even if it does not necessarily resemble to the experience in the real world. For instance subjects could be surprised when the experience changes in an unpredictable way, or when the expectancies they have formed on the experienced environment are not fulfilled.

The philosopher Donald Davidson is in fact also the proponent of a nice test for objectivity based on the reaction of surprise[18]. Someone puts his hand in his pocket and finds a coin. If he his surprised in finding the coin, then he comes to believe that his previous belief about his pockets and coins was false. In this way he becomes aware that there is an objective reality which is independent from (previous) beliefs. In fact, it is not possible to be surprised without possessing some beliefs (in the holistic view of Davidson to possess a belief is to possess a set of interconnected beliefs); reciprocally, Davidson states, if one possesses some beliefs he is exposed to the possibility of being surprised. In fact, something can happen, that makes him change his mind. But for being surprised, the subject has also to be aware of the contrast between what he was used to believe and what he is coming to believe. Surprise as frustrated expectation indicates the existence of beliefs about the experienced world.

The subject that can be surprised possesses the concept of belief (a belief concerning beliefs), then the concept of an objective truth that is independent from beliefs.

*Pragmatic indications from the studies on objectivity*

The philosophical analysis of the conditions of objectivity suggests at least two considerations for the production of believable experience. The notion of re-identification indicates that several expositions to the same object maybe necessary in order to re-identify it, thus to come to consider the object as objective. Additionally, the sharing of a common causal world with other subjects or the condition of intersubjectivity might play a relevant role for the objectivity and believability of the experience.

The discussion about objectivity also suggests some possible conditions that can be assessed in order to estimate the believability of mediated interactions:

- re-identification test: assess the capacity of re-identification of an object after it has disappeared;

[18] Davidson, 1982

- surprise test: assess the reactions of surprise when the object is modified or violates some natural laws; a possible test might include the stretching of the conditions of believability, by modifying the characteristics of a believable object until it becomes unbelievable; this test might show how different a believable object can be from a real object.

**Conclusions**

Are there good reasons for introducing the notion of 'believability'? Do we really need another notion for characterizing the experience in mediated interactions?

I maintain that the notion of 'believability' presents some conceptual advantages in respect to the notion of 'presence' and the notion of 'realism'. Believability is somehow related to realism, but is not realism in its photorealistic meaning; believability is somehow related to presence, but it is not presence in the sense of a private feeling experienced by the user or in the sense of a sensation connected with a spatial experience.

Believability in fact takes into account the way human beings perceive the objects and events of their environment. It is not simply a matter of being here or of being there, nor a matter of a subjective feeling: it regards the mechanisms by which human beings perceive and form beliefs about objects and sensations as something true, external and intersubjectively valid. Perceived objects are something more than mere stimulations and something different from subjective experiences.

How are believable objects made? It's trivial that real objects of the real world are credible. Then, virtual worlds' designers do not have but to faithfully reproduce the objects of the real world! Virtual reality devices and computer sciences have impressively developed but not as much as to exactly reproduce the physical characteristics of real objects. It is then necessary to turn from the attributes of the objects of the external world to the characteristics of the perception and to the conditions that make normal perception a believable experience. The characteristics of perception include both the characteristics of the stimulus condition and the conditions of the perceiver (the actions the perceiver is

allowed to perform and its social exchanges). The characteristics of a believable experience make reference to the construction of objects in perception and to the perception of objectivity.

When these conditions are respected, a pattern of stimulation can give rise to a believable experience even if the pattern of stimulation is not a point to point replica of all the physical aspects of the real world.

In this way it is possible to give rise to new experiences, experiences of objects or events or sensations that the user has never made before, that he cannot recognize and that are not replicas of the objects and events of the real world.

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