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Presence as Being-in-the-World

Abstract

An alternative view of presence is introduced based on existential philosophy and ecological psychology. This view favors a Heideggerian/Gibsonian metaphysic over the more conventional rationalistic orientation. In this alternative view, notions of subjective presence and objective presence no longer exist. Presence is instead tied to one's successfully supported action in the environment, this environment being either virtual or real. The coupling between perception and action is crucial for determining the extent to which actions are successfully supported. It is argued that this alternative view provides needed guidance and simplification for the evaluation of presence.

1 Introduction

The term *presence*, as standardly conceived, is concerned with the subjective feeling of existence within a given environment (Heeter, 1992; Sheridan, 1992; Slater, Usoh, and Steed, 1994; Steuer, 1992). This notion of presence, the feeling of “being there,” is considered central to teleoperation¹ and virtual reality² endeavors, and has been since its conception (Minsky, 1980).³ As a result, it is not surprising that considerable effort has been devoted to questions that follow from presence definitions, for instance: What determines presence? How may presence be measured? In the examination of these questions, comparison is made, often implicitly, to the notion of presence in real-world situations: the feeling of, as well as the physical facts of “being here.” Though such comparison may at first glance seem to plant examinations of presence in teleoperation and virtual reality systems on firm theoretical ground, this is in fact far from true. Philosophers have toiled with just such questions as to the nature of existence in the world for centuries. Ontology is the proper name for such study, a subfield of metaphysical inquiry.

In this article two major philosophical positions on the nature of existence—ontology—are reviewed. One position asserts that an understanding of exis-

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1. Teleoperation systems provide an operator the ability to manipulate some form of actuator remotely located in a real environment. Control of a robotic arm for moving radioactive canisters provides a canonical example of a teleoperation system. Systems of this type typically attempt to provide the operator with much (if not all) of the sensory information that would be available if the operator were physically placed in the environment of the actuator. In order to provide this information, exotic hardware in the form of stereoscopic visual displays, 3D sound, and tactile displays are often, though not necessarily utilized.

2. Virtual reality systems are similar to teleoperation systems in that they attempt to functionally place the operator in an environment distal to the operator's bodily position. In the virtual reality case, however, this environment is entirely computer generated, and therefore is not grounded in the real physical world.

3. Minsky is one of the first to coin the term “telepresence,” the feeling of remote existence in a teleoperation system, stressing its importance in teleoperation and virtual reality systems.

tence rests on an understanding of the relationship between psychological and physical domains. This position is referred to as the rationalistic tradition. It is the metaphysical view underlying the vast majority of current theorizing in such varied fields as perceptual psychology and artificial intelligence. We contend that this view also underlies current virtual reality and teleoperator system theory. An alternative position holds that existence is tied to our normal, everyday physical interaction with the physical environment. Both the philosopher Martin Heidegger and the psychologist J. J. Gibson are proponents of this latter position.

Elucidation of these ontological views has much to offer the study of presence. Indeed, ontological views underwrite what presence is defined to be, what the determinants of presence are, and how presence may be measured. We argue that a shift in ontological view, from the rationalistic tradition to a Heideggerian/Gibsonian view, offers a simplified framework from which to address questions of this nature. Since a similar call for metaphysical reorientation has recently taken place in the artificial intelligence field (Dreyfus, 1991; Winograd and Flores, 1986), allusion to it will be made throughout this work.

We will begin with a description of the rationalist position, including mention of rationalism in the cognitive sciences. It will then be argued that, just as with much of the cognitive sciences, virtual reality and teleoperation research rests on a rationalistic orientation. Description of a position alternative to rationalism is provided by exposition of the views of both Heidegger and Gibson. Finally, implications of this alternative position for presence in virtual reality and teleoperator systems are discussed by way of conclusion.

2 Rationalistic Tradition

Rationalism has enjoyed a rich history, with traceable origins to Descartes, Spinoza, and Leibniz. Most generally, rationalism is a theory of knowledge acquisition. It holds that knowledge is obtained on the basis of reason, or rationality. This is classically opposed to the stance that knowledge is acquired through experience:

the empiricist stance. It is not the aim to rehearse the rationalist/empiricist debate here, but rather to provide a sufficient characterization of the rationalistic position so as to be able to spot the implicit rationalism in current presence research.

Winograd and Flores (1986) characterize the rationalistic approach by examining the methodological machinery typically employed by the rationalist when attempting to solve a problem. They assert that three general steps are involved in this method (Winograd and Flores, 1986, p. 15):

1. Characterize the situation in terms of identifiable objects with well-defined properties.
2. Find general rules that apply to situations in terms of those objects and properties.
3. Apply the rules logically to the situation of concern, drawing conclusions about what should be done.

If issues pertaining to precisely how it is that situations may be represented as objects with properties, and how it is that general rules applying to situations may be found, are abated for the time being, the rationalistic approach seems to make sense. Simply set up a framework for problem solution in which one may apply a formal system of logic to arrive at a conclusion. Indeed, the scientific method follows essentially this form (Winograd and Flores, 1986). This is perhaps why the rationalistic tradition has been so ingrained in the minds and practices of much of the scientific community.

This general rationalistic framework has been widely adapted to the domains of cognitive and perceptual psychology. In such endeavors, the first representational step in the process is further refined in the following way: The type of representation formed to characterize the situation is some form of internal mental representation. Therefore, this step in the process becomes a crucial one, in that it is here that the realm of the physical objects is transduced to the mental, subjective, realm. To be sure, these mental representations are not mere copies of the external objects to which they refer, but are rather symbolic descriptions of those objects. The rest of the process follows similarly to the general rationalistic framework: Find rules that apply to the representations

of the situation, and then apply these rules logically to arrive at a conclusion. This framework underwrites the information processing approach to perception and cognition, an approach that currently secures the position of dominant paradigm in these respective fields.

The information processing approach generally considers the digital computer as a metaphor for the process of cognition as well as of perception, inasmuch as it is a process of intelligent problem solving. In such a metaphor, the “program” is taken to be analogous to mental function (via algorithmic symbol manipulation), and the “hardware” is the physical computational engine in which the program(s) is implemented; the brain in this case. “The task of the psychologist trying to understand human cognition is analogous to that of a man trying to discover how a computer has been programmed.”

(Neisser, 1967, p. 6). Artificial intelligence is concerned with the inverse problem, that is, given implementation of a certain program, on nonbiological hardware, to what extent is human cognition replicated? Hubert Dreyfus (Dreyfus, 1992) has offered, now classic, criticism against artificial intelligence of this type (intelligence via rule-based symbol manipulation). He argued that, in addition to the unjustified belief that the mind functions like a digital computer (the “psychological assumption”), and that programs implemented on this “computer” are capable of formalizing human thoughts and feelings (the “epistemological assumption”), the artificial intelligence project assumes that the data about the human environment, data utilized in cognition, consists of discrete and explicit bits that can be algorithmically processed (the “ontological assumption”). To the extent that this brand of artificial intelligence is the inverse of cognitive psychology’s information processing approach, these criticisms dually apply. For the purposes of this investigation, the third criticism is most relevant.

In addition to Dreyfus’s ontological criticism, it has been claimed that a form of residual dualism is present in rationalistic approaches to artificial intelligence and cognitive psychology (Searle, 1984). Such dualism stems from the strict separation of mental (nonphysical) and physical domains. The mental domain is considered to be the purely subjective world of an individual’s thoughts and feelings (or a computer’s programs and

symbols), whereas the physical domain is the objective world of physical reality. Winograd and Flores (1986, pp. 30–31) put it best when they outline the “taken-for-granted” assumptions integral to this rationalistic view:

1. We are inhabitants of a ‘real world’ made up of objects bearing properties. Our actions take place in that world.
2. There are ‘objective facts’ about that world that do not depend on the interpretation (or even the presence) of any person.
3. Perception is a process by which facts about the world are (sometimes inaccurately) registered in our thoughts and feelings.
4. Thoughts and intentions about action can somehow cause physical (hence real-world) motion in our bodies.

It is further claimed by many cognitive and perceptual psychologists (unknowingly rationalist) that perception is a representational process (Marr, 1982; Rock, 1983). Given this claim, it may be noted that Dreyfus’s ontological criticism applies, then, to this third assumption: asserting that it is not possible for representations to fully characterize the human environment.

The incommensurability of mental and physical domains is a source of problems for the rationalistic view. This view must constantly be concerned with the relationship between the two domains: What are the causal relations between the two? To what extent are the two similar? How may the mental domain be submitted to measurement? Perceptual veridicality serves as an example of these issues. On the rationalistic view, perceptions are veridical if states of affairs in the real, physical world match (in some sense) the perceiver’s phenomenal, mental world. Since the perceiver’s phenomenal world is, presumably, a representation of the physical world, the nature of this representation must be exposed in order to determine veridicality. This exposition causes an arguably intractable problem: It can never be determined with certainty that methods utilized in probing representations accurately recover the perceiver’s phenomenal state. That is, it simply is not possible to know whether a subject’s reports of represented phenomenal states are true to the representations themselves.

In summary, the rationalistic orientation subscribes to a form of dualism in which mental and physical domains are separated. This may be referred to as a distinction between subject and object. Further, understanding the relationship between mental and physical domains is of paramount importance to the rationalistic view. Representations are conceived of as doing the work of getting the outside inside, or transducing the physical to the mental.

Finding these rationalistic tenets particularly unproductive, certain artificial intelligence researchers have discarded the rationalistic orientation in favor of a Heideggerian view (Agre, 1988; Winograd and Flores, 1986), a move thought to hold great promise for rejuvenating the degenerate (rationalist) artificial intelligence research program. It is contended that a similarly lucrative path may be followed for presence research. The rationalistic threads within current presence research must first be exposed, however. This is the topic of the next section.

3 Presence and Rationalistic Tradition

Current research on presence in virtual reality and teleoperator systems subscribes, in one way or another, to the rationalistic orientation. To bolster this assertion, four examples of rationalistic predispositions in these research programs will be examined: first, examples of the subject/object distinction, followed by the representational stance, views on environmental formalization, and finally thoughts about the term *virtual reality*.

The term *presence* has been criticized as being ill-defined (Gilkey and Weisenberger, 1995; Held & Durlach, 1992; Sheridan, 1992). One of the principal reasons for this criticism has been the problems surrounding the measurement of presence. In general, two types of measurements have been proposed: subjective measures and objective measures. Subjective measures probe a person's feeling of presence in a given environment; such measures are often collected via a rating scale type of report. Objective measures, conversely, are concerned with observable (hence physical) performance in some form of task. It has been widely recommended—as well

as implemented (Hendrix and Barfield, 1996a,b)—that proper presence measures incorporate both subjective and objective measures (Held and Durlach, 1992; Sheridan, 1992, 1996). Such recommendation seems to imply the possibility of differing or conflicting results between subjective and objective measures. That such conflict is even considered points to a clearly rationalistic orientation, specifically that of a subject/object distinction.

In addition to this subjective/objective measure distinction, a number of works have explicitly posited the existence (and primacy) of mental representations, a further rationalist mainstay. Sheridan (1992) argues that subjective measures of presence are required to gain knowledge about a person's mental contents, just as is true in research examining mental models. Therefore, it appears that, just as with mental modeling, representations of an environment and its objects are assumed to exist, and the way to gain knowledge about such representations is through subjective measures. Slater, Usoh, and Steed (1994) are even more explicit about this assumption: "These (factors contributing to presence) concern how the perception generated by the IVE (immersive virtual environment) are mediated through the mental models and representation systems that structure participants' subjective experiences." Loomis (1992) refers to representations similarly: "The perceptual world created by our senses and nervous system is so functional a representation of the physical world that most people live out their lives without ever suspecting that contact with the physical world is mediate." Hence, it is clear that common consensus holds a strict distinction between mental and physical worlds, and further, it is representations that bridge the gap between these two worlds.

This view on representations is closely related to the issue of virtual environment formalization. In order to construct a virtual environment, a description of the environment to be constructed is required. Current instantiations of virtual reality systems provide environmental description in the language of geometry and kinematics, such description having atomistic, determinate, parameters (such as position or intensity or torque) as its primitives. For virtual environments described in this

fashion, presence is conceived as being contingent upon transfer of a sufficient amount of information so as to properly specify the geometry and kinematics of the particular environment being modeled to the user (Hendrix and Barfield, 1996a,b). Just as artificial intelligence research (rationalist) has been criticized for assuming that it is possible to specify all relevant environmental information atomistically (Dreyfus's "ontological assumption" criticism), so may current virtual reality research be similarly criticized. Such an assumption is rooted in rationalistic tradition.

Finally, it is contended that the term *virtual reality* serves as an additional clue to an underlying rationalistic orientation. The existence of a virtual reality seems to tacitly assume that the existence of "real reality" is unimpeachable—a rationalist assumption. This is far from true. In fact, solipsism (the view that the physical world does not truly exist, all that exists are subjective, mental worlds) has never been successfully disproven.

At this point, the rationalistic underpinnings of presence research should be clear, as it has been shown that much of this research utilizes rationalistic tools: distinctions between subject and object, recourse to mental representations, and atomistic formalization. Taken together, subscription to subject/object distinction and mental representation creates problems for presence examination. Researchers are forced to continually relate subjective feelings of presence to objective facts of presence,⁴ both through theory and measurement. Further, appeal to representations as the relational engine gains nothing, arguably, since such representations are not subject to independent confirmation. The atomistic formalization of relevant environmental properties is additionally problematic. We now turn to an examination of a metaphysical view alternative to rationalism, that of Heidegger's phenomenal existentialism and Gibson's perceptual theory. This view will be seen to avoid many

of the issues problematic to the rationalistic tradition, casting presence in a new metaphysical light.

4 Heidegger

Martin Heidegger, a mid-twentieth century German philosopher, was principally concerned with the question of what it means *to be*. This ontological question, he argued, had been fundamentally downplayed since the time of Plato. Indeed, Heidegger found himself at odds with Descartes' standard conception of a human being as a *res cogitans*—a thinking thing. On this view, there is nothing more immediate and self-evident than our own mental contents. The very act of probing these mental contents—thinking—guarantees our existence. *Cogito ergo sum* (I think, therefore I am), claimed Descartes. Heidegger was unsatisfied with this account, claiming that though it may prove human existence (albeit in an incorrect fashion, he contended), it certainly said nothing about the nature of human existence—what it means to be human. Heidegger's method for examining existence questions of this nature was formed around an approach to interpreting ancient texts known as hermeneutics. Such an approach contends that meaning is contingent upon interpretation, and interpretation is never entirely detached and analytic, but is always to some extent biased by factors such as the interpreter's beliefs, language, and practices. Likewise, Heidegger felt it was not possible to adopt a detached, analytic viewpoint for examination of what it means to be, since such an examination takes place in the context of certain physical, social, and historical states of affairs.

A capsule view of Heidegger's work will be provided by the examination of two Heideggerian concepts: the concept of "thrownness," and the concept of "readiness-to-hand."

4.1 "Thrownness"

One example of Heidegger's take on the nature of existence concerns the way in which we interpret the environment or situation we are in. He claims that we are "thrown" into situations in which we must continu-

4. The meaning of *objective* presence here is twofold. In real environments, objective presence is simply the physical fact of one's corporeal existence. In virtual and teleoperator environments, objective presence is taken to be the ability of the operator to effect change in that environment, change that is confirmable, independent of the operator (Schloerb, 1995).

ally act and continually interpret. In order to provide insight into this condition of “thrownness,” consider the following situation (adapted⁵ from Winograd and Flores, 1986): You are a jazz musician playing in a small improvisational group, a quartet, say. You are the undisputed leader in the group. While others may be featured from time to time, you are the one that generally controls the flow of the music. A number of points describe your situation.

1. Action is unavoidable. As the music progresses, you are continually playing, either as the featured player or, occasionally, as part of the backup. Playing is action. Even if you are not playing, during a brief respite after a long solo, you are still in action, since your not playing and leading the group at that time also has consequences for the group’s playing.
2. Detached reflection about action is impossible. It is not possible to simply stop and analyze your actions during the course of playing. Actions must take place immediately in order to respond to the group’s playing. After the song is over, you may of course think to yourself that you should have played a series of notes differently, taken a faster tempo, and so on.
3. Action effects are unpredictable. Even if it were possible to step back from the situation and analyze potential outcomes of your actions, the effects of these actions cannot be predicted. If you suddenly change the nature of your playing, perhaps you change rhythm or key, the rest of the group may conceivably be inspired by this innovation and play with renewed vigor. It is also conceivable that the group may dislike your changes, losing their playing energy. You must simply, as Winograd and Flores (1986) state, “go with the flow.”
4. Stable representation of the situation is impossible. There is no musical score, no written notes. You are all simply improvising. After the song ends, you

5. Winograd and Flores (1986) consider the example of a corporate-style meeting, in which you (the reader) are the leader. We prefer this jazz musician example, since it stresses the importance of the dynamic and continuous nature of the participant/environment interaction.

may be able to represent the situation: this solo did this, followed by that solo doing that, and so on. During the song, however, such an analysis is impossible, since you do not have a complete picture of the situation.

5. Representation is interpretation. Even though it is possible to form a representation of the situation after the fact, after the song is over, this representation is still a relativistic interpretation. After a really good set, you might want to attempt to write down some of the music for future reference. Your transcription of the music is surely influenced by your current experiences and mood state. If another member of the group, less enamored of the set than you, were to also write down the music, his score would undoubtedly be different from yours. Each of you has the potential to interpret the song differently.

Just as you (the jazz musician) are “thrown” into the situation of the jazz performance, Heidegger contends that we all exist in the world in this type of “thrown” state. We are all continually acting and therefore not able (under normal circumstances) to represent the situation at hand in a detached analytic fashion. This type of “thrown” existence, Heidegger feels, more accurately describes the fundamental nature of human existence. This nature of existence he terms our “being-in-the-world.”

4.2 “Readiness-to-hand” and “Break-down”

Just as Heidegger proposed a special way of existence within a situation or environment, that of “thrownness,” he contends that interaction with objects follows a similar path. He argues that when one is engaged in purposeful, or *concernful* action (to use the translation of Heidegger’s term), stable representations of objects as tools or equipment do not exist.

Equipment can genuinely show itself only in dealings cut to its own measure (hammering with a hammer, for example); but in such dealings an entity of this kind is not grasped thematically as an occurring

Thing, nor is the equipment-structure known as such even in the using. (Heidegger, 1962, p. 98)

Instead, objects are conceived of according to their usefulness in whatever task is currently being performed. This type of usefulness Heidegger terms “readiness-to-hand,” hence characterizing the way equipment exists relative to the user. Further, when engaged in this task, the tools themselves become transparent to the user.

That with which our every-day dealings proximally dwell is not the tools themselves. On the contrary, that with which we concern ourselves primarily is the work—that which is to be produced at the time. (Heidegger, 1962, p. 99)

Therefore, if the example of hammering is considered, as Heidegger does, the concerned action of hammering precludes the user from possessing a stable representation of the equipment utilized in the action, thereby rendering the equipment transparent to the user. The hammer itself, then, under these conditions of normal action is “ready-to-hand.”

Certain extraordinary conditions do exist where the user may come to possess representations of equipment (objects), however. The equipment then ceases to be “ready-to-hand” and becomes “present-at-hand,” that is nontransparent to the user. These are situations in which “break-down” has occurred, claims Heidegger. In the example of hammering, it is only in situations where the hammer slips or breaks or misses its target that the properties the hammer possesses, other than those normally utilized for the concerned action of hammering, are revealed—become “present-at-hand.” Similarity exists between the conditions of “throwness” and “ready-to-hand” equipment. In both cases action precludes stable representation—representation of environmental properties, in the former case, and object properties, in the latter. Conversely, both situations of detached analysis and “break-down” do allow for representation possibility (of situations and objects, respectively). Such situations are clearly considered to be secondary to the primary, everyday modes of “throwness” and “ready-to-hand” equipment.

It is these concepts of “throwness” and “ready-to-

hand” equipment that certain Heideggerian artificial intelligence researchers have found particularly useful (Agre, 1988; Winograd, 1995; Winograd and Flores, 1986). Instead of researchers building an artificial intelligence system in which properties of objects are construed as sets of atomistic, determinate features (the rationalist procedure), things in the world are instead incorporated into the system, or formalized⁶ according to their potentials for action/interaction with the system itself, their “readiness-to-hand.” A basketball is not represented by the features *round*, *orange*, and *rubber*, but instead is viewed for its *throwability*, its *rollability*, or its *bouncability* by the system. The system’s “thrown” relationship with the environment is similarly conceived. Full-featured representations of the environment are never available to the system when it exists in an informationally rich, dynamic environment. Partial functional relationships are all that is available.

4.3 Heidegger Summary

Heidegger’s examination of what it means to be may be viewed as a fundamental reorientation from the rationalist position on existence. Where the rationalist chooses to make strict separation between subjectivity and objectivity, subject and object, mental and physical, Heidegger claims that such separation does not adequately describe our nature of existence in the world. This “being-in-the-world” is our primary and everyday mode of existence. In this mode we do not have stable mental representations of objects or our environmental relationship. Such representations are not impossible, however, as in the cases of detached contemplation or “breakdown,” but are not to be viewed as primary modes of existence. Dreyfus puts the relationship of these modes in perspective:

We should try and impress on ourselves what a huge amount of our lives—dressing, working, getting

6. Heidegger himself feels that formalization attempts are “hopelessly misguided” (Dreyfus, 1991). Heideggerian artificial intelligence researchers do not share this view. They instead argue for types of formalization based on Heidegger’s ontology. This view may therefore be considered a middle ground between strict Heideggerian and rationalist views on formalization.

around, talking, eating, etc.—is spent in this state (the “thrown,” non-analytic state), and what a small part is spent in the deliberate, effortful, subject/object mode, which is, of course, the mode we tend to notice, and which has therefore been studied in detail by philosophers. (Dreyfus, 1991, p. 67)

Being, then, in this Heideggerian sense, is defined in terms of action within a worldly context. Existence is action and action is existence.

How might presence be construed on this Heideggerian view? It appears that presence, as a feeling of existence within an environment, is only relevant in this latter nonprimary mode of existence. Reporting a feeling is reporting that which is mentally represented. In order to report mentally represented things, one must step back from the primary mode of existence. But stepping back removes one from exactly the existence mode of interest, the primary mode of existence, that of concerned action.⁷ It is therefore crucially important, in this view, that the potential for concerned action be provided in virtual reality and teleoperation systems⁸ in order for presence to result.

5 Gibson

Even though Heidegger’s metaphysical views may seem obscure, especially in the light of most modern theories of cognitive and perceptual psychology, they are in fact not. The perceptual theory of J. J. Gibson shares a great deal with the Heideggerian orientation. The relationship is so great that it has recently been argued that

7. By way of anecdotal support, Schloerb (1995) agrees with this notion of the possibility of stable existence representation only while one is not engaged in concerned action. “For example, *if you stop and think about it* (emphasis added) you will (no doubt) perceive that you are physically present in some environment.” (Schloerb, 1995, p. 65).

8. Heidegger is often wrongly construed as being opposed to modern technology. It is therefore not improper to apply Heideggerian concepts to an area that depends crucially on technology. Both Heim (1993) and Coyne (1994) point out that the technology used in virtual reality and teleoperation systems may in fact be viewed as an enabling device for uncovering truth about the nature of our existence, our presence. Such an enabling function vindicates the use of technology in Heidegger’s eyes (Heidegger, 1977). The analogous point has been made by Winograd (1995) in the artificial intelligence domain.

Heidegger’s explicitly stated ontology may in fact be used to fill in certain ontological gaps in Gibson’s perceptual theory (Kadar and Effken, 1994). Briefly, Gibson’s perceptual theory (Gibson, 1979)⁹ holds that perception is a direct process of picking up information from an informationally rich environment. Information is not to be confused with proximal stimulation, but rather to be viewed as properties of the environment that uniquely specify that environment. Hence, the environment is both the object of perception, and the source of perceptual information. Gibson’s unique insight rests with the notion that the perceiving organism and the environment are intimately related—namely, that the environment has provided conditions commensurate with the organism’s evolution. As a result, perception for the organism is the pickup of information that supports action, and ultimately evolution. Gibson terms this action-supportive information an *affordance*. Therefore, it is the affordances the environment provides the organism that are the proper objects of perception, these objects being directly perceived (that is, apprehended without intervening mental representation).

It is contended that Gibson’s theory shares similarity to the Heideggerian view both in its ontological stance and its position on mental representations. Examination of this perceptual theory will be shown to provide additional and useful insight into the characterization of presence.

5.1 Gibsonian Ontology

For Gibson, the nature of existence of an organism is always considered in relationship to its environment. Actions of the organism have consequences for the environment, and the nature of the environment has consequences for the organism. Hence, Gibson’s ontology is that of a reciprocity between perceiver and environment (Lombardo, 1987). This notion is fundamentally the same as Heidegger’s notion of the relationship between

9. Gibson’s final 1979 book is chosen as the exemplar of his theory. Ontogenesis of this theory is clearly seen in earlier works (Gibson, 1950, 1966), however.

interpreter and interpreted. Both Gibson and Heidegger strictly reject the rationalistic notion of separation of subject from object.

As a result of this ontology, Gibson proposes a revised view of perceptual veridicality. On the rationalist view, perceptions (that which makes up an internal phenomenal world) are veridical if they match the states of affairs in the real objective world. Gibson instead proposes that perceptions are veridical to the extent that they support successful action in the environment (Gibson, 1979). This view may be considered similar to Heidegger's "thrownness," since one can never step back and determine veridicality as viewed in the former sense. Therefore, both Gibson and Heidegger move the locus of veridicality determination from the mental states of the perceiver to the environment where action may take place: Ecology replaces phenomenology. Mace (1977) eloquently states this redirection as the following directive: "Ask not what's inside your head, but what your head's inside of."

Stemming from this view of veridicality and ontological position, Gibson also posits an alternative view of the objects of perception. Whereas the rationalist holds that the process of perception produces mental representations of a given environmental object's properties, Gibson claims that the objects of perception are to be understood in terms of possible action relationships with the perceiver, or affordances. For example, a hammer in the environment is perceived as affording the action of hammering, not as a collection of properties such as size, color, or mass. This notion of affordances, then, appears strikingly similar to Heidegger's notion of the relationship between users and "ready-to-hand" equipment.

5.2 Gibson and Representations

Following from his ontological stance, Gibson contends that mental representations are superfluous. What better representation of the environment exists than the environment itself? Resulting from the reciprocal nature of perceiver and environment, information is always available to the perceiver that uniquely specifies

the natural environment.¹⁰ Some of the strongest criticism directed to Gibson has centered on his view of representations. Fodor and Pylyshyn (1981), in their critique of Gibsonian perceptual theory, provide a useful distinction between two types of properties of perceptual objects: projectable properties and nonprojectable properties. Projectable properties are fully determined by the physical properties of stimulation (e.g., spatial layout or motions). Nonprojectable properties are necessarily underdetermined by physical stimulation (e.g., *shoeness*, *mailbox-ness*, or edibility), requiring additional top-down, cognitive information as supplement. It is clear, then, that a representational framework is required for the perception of nonprojectables, since integration of bottom-up and top-down types of information is required. Fodor and Pylyshyn (1981), therefore, contend that Gibson's theory cannot account for the perception of nonprojectables, as it does not posit a representational framework. Epstein (1993) points out, however, that one way of reading Gibson's ultimate work (Gibson, 1979) is as an argument for mass reallocation of nonprojectables to projectables, hence circumventing the problem of nonprojectable perception.

Similarities of this Gibsonian take on representations to Heidegger's view are clearly evident. Both views greatly downplay the necessity of representations, since forms of dualism are not appealed to. Whereas Gibson moves to entirely discount representation, Heidegger merely holds that normal, everyday perception is representation-free.¹¹

5.3 Gibson Summary

Gibson's theory represents a radical reformation of perceptual theory. Counter to standard theories based

10. This is, of course, not necessarily true in environments where stimulation is impoverished. Gibson strongly criticized mainstream perceptual research (largely rationalist) for conducting experiments under conditions of impoverished and unnatural stimulation. Such experiments, he contended, divulge little about the way perceptual systems behave in the real world, an environment rich in stimulation.

11. Epstein (1993) argues in favor of a position more commensurate with Heidegger's, claiming that the representational framework is only utilized under certain specific cases requiring analytic modes of perception.

on the rationalistic approach, Gibson's theory does away with the separation of phenomenal and physical domains, and hence the need for mental representation postulation. Where standard theories profess phenomenology as perception's product, Gibson asserts a functional relationship between perceiver and environment, environment and perceiver. Hence, Gibson's environment is not the same as the rationalist's physical world, since an ecological relation exists between perceiver and environment. The environment is what it is owing to the existence and actions of perceivers. Perceivers are what they are owing to the support of action by the environment. Gibson's view, then, on the relationship between environment and perceiver is aligned with that of Heidegger. Further, Gibson's notion of affordances is also similar to Heidegger's views on equipment-user interactions.

How do Gibsonian views contribute to a modified view of presence? First, existence surely is a projectable property, since it must be fully determined by physical stimulation. (This is, of course, not to say that this stimulation is necessarily related to the physical environment, as in the case of a virtual environment.) If existence is a projectable property, than self-existence should also be a projectable property, it seems. Therefore the perception of self-existence is completely determined by physical stimulation.¹² To the extent that successful action is supported, perceptions of self-existence are veridical. (This idea is similar to Heidegger's notion of "throwness.") If we consider that there exists at least one action of the self that is successfully supported in a given environment, then perception of self-existence must be veridical. Hence, presence is tied to action in the environment.

12. Note that this view, that of presence being completely determined by physical stimulation, is consistent with the notion of an ideal virtual reality system. In such a system, the physical stimulation reaching all of the user's sensory systems (proximal stimulation) may be controlled such that it is possible to precisely replicate stimulation that would impinge upon the user in an arbitrary environment distal to the user's actual physical location. In such a case, it is hypothesized that the user would (in some sense) actually exist in this distal environment, quite apart from *feelings* of existence. Dennett (1978) provides useful discussion of these sorts of issues via a 'brain-in-a-vat' metaphor.

6 Conclusion: Presence and the Heideggerian/Gibsonian Tradition

An unexpectedly simple working definition of presence has therefore been arrived at: *Presence is tantamount to successfully supported action in the environment.* The environment may be either virtual or real, as well as local or remote in relation to the operator. This form of presence definition is reached only through an abandonment of rationalistic tradition and a reorientation to Heideggerian and Gibsonian views. Such a definition should not be confused with that of the rationalist choosing to simply ignore the subjective components of presence and focus on the objective. Both Gibson and Heidegger deny that any type of subjective component of presence exists at all, under conditions of concerned action in the environment.

Others have alluded to the importance of action in virtual reality and teleoperator systems, many claiming that it is one of a collection of determinates of presence (Held and Durlach, 1992; Sheridan, 1992; Steuer, 1992), or of virtual reality (Zeltzer, 1992). The currently proposed definition of presence differs from these past conceptions in that only a single determinate of presence is posited: Successfully supported action in the environment is a necessary and sufficient condition for presence.

But what specifically is meant by *successfully supported action*? When actions are made in an environment, the environment reacts, in some fashion, to the action made. When the environmental response is perceived as lawful, that is, commensurate with the response that would be made by the real-world environment in which our perceptual systems have evolved, then the action is said to successfully support our expectations. Since our knowledge of such environmental response is necessarily gained through perceptual processes, it may be seen that the coupling between perception and action is crucial in determining the extent to which actions are successfully supported. Such ecological perception/action coupling must therefore be ultimately related to presence.¹³

13. Smets et al. (1995) have also made reference to this relation in their examination of virtual reality technology as a design aid.

The claim that presence is related to perception/action coupling is to some extent vacuous. One is quickly led to ask questions as to the nature of such coupling. It is already well known that severing ecological coupling in one form or another has profound effects on action and task performance (e.g., on the existence of excessive time delay between action and perception). Indeed, Gibson offers a number of candidate invariants of the physical world that the visual system may exploit in the process of perception (for example, optical structure invariance in the face of changing illumination and changing viewer perspective). Preservation of similar invariant structure for the additional sensory modalities seems to be at least a starting point in attempting to characterize natural perception/action coupling. Perhaps support of these invariants in a virtual or remote environment might represent a set of minimal conditions for the perception of lawful environmental response to action.

Consider instead the utilization of a virtual reality system itself as a means for perception/action coupling examination. By design, such systems have formalized environmental responses to the actions of the perceiver/actor. These responses may or may not be perceived as lawful. Therefore, the coupling between perception and action may or may not be considered lawful. It is possible, however, to assess the degree of lawfulness by making comparisons to a real-world situation analogue. Specifically, the dynamics of the actor's actions are compared between real and virtual environments for the same task. From the similarity between actor dynamics in the two environments, one may infer the similarity of perception/action coupling. High similarity implies perception/action lawfulness in the virtual environment. Given the virtual environment architecture, it is possible to do much more than simply describe the degree of lawfulness in coupling, however. One could, in theory, fine-tune the parameters in the virtual environment formalism so as to maximize the similarity between real-world and virtual environment actor dynamics. On achieving this maximization, formalization of lawful perception/action coupling has been achieved via the virtual environment formalism. Hence, the virtual reality

system, when similarity in actor dynamics is maximized between analogous virtual and real environments, serves to formalize ecological perception/action coupling, thereby formalizing presence, given a Heideggerian/Gibsonian ontology.

Examination of ecological perception/action coupling in this fashion applies a number of key Heideggerian/Gibsonian concepts. First and foremost, this method is principally concerned with the dynamic interaction between perceiver and environment. It is the normal and lawful interaction with the real-world environment that is considered primary to our way of existing in the world, our "being-in-the-world." These real-world dynamics are therefore the criterion against which virtual (or remote) environment interactions may be judged as lawful, and presence inferred. Things in the environment are not merely sets of discrete, atomistic features. They afford potentials for interaction with perceivers/actors—they are "ready-to-hand." Additionally, the utilization of a virtual reality system to monitor these interactions is unobtrusive, and therefore does not interfere with the perceiver/actor's "throwness" in the environment. Further, this method does not depend on the subjective thoughts or feelings of the perceiver/actor, nor does it depend on objective measures of task performance. How well a task is completed, or how it feels to do a task is irrelevant. How the task is done, in terms of the dynamics of the perceiver/environment interaction is all that matters. Not only does a metaphysical change to a Heideggerian/Gibsonian orientation offer guidance in the evaluation of presence in virtual or remote environments, but the technology utilized for these environments potentially provides a means of formalizing generally the nature of our existence in the environment.

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