Information and direct perception: a new approach

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Introduction

Since the 1970s, Michael Turvey, Robert Shaw, and William Mace have worked on the formulation of a philosophically-sound and empirically-tractable version of James Gibson's ecological psychology. It is surely no exaggeration to say that without their theoretical work ecological psychology would have died on the vine because of the high-profile attacks from establishment cognitive scientists (Fodor and Pylyshyn 1981, Ullman 1981). But thanks to Turvey, Shaw and Mace's work as theorists and, perhaps more importantly, as teachers, ecological psychology is currently flourishing. A generation of students, having been trained by Turvey, Shaw and Mace at Trinity College and/or the University of Connecticut, ecological psychology, are now distinguished experimental psychologists who train their own students in Turvey-Shaw-Mace ecological psychology. Despite the undeniable and lasting importance of Turvey, Shaw and Mace's theoretical contributions for psychology and the other cognitive science, their work has not received much attention from philosophers. It will get some of that that attention in this paper. I will point to shortcomings in the Turvey-Shaw-Mace approach to ecological psychology, and will offer what I take to be improved versions of two important aspects of it. In particular, I will describe theories of information and of direct perception that differ from the Turvey-Shaw-Mace account.

Given the debt that those of us who wish to pursue ecological psychology owe to Turvey, Shaw and Mace, this, no doubt, seems ungrateful.[2] Perhaps it is. But I would argue that because of the success of the Turvey-Shaw-Mace approach to ecological psychology, the field has become a true contender in psychology, cognitive science and artificial intelligence. Given the stability of ecological psychology and its standing as a research program, it can withstand some questioning of the assumptions on which its current practice is founded. This is

especially the case if the questioning is aimed at firming up foundations rather than tearing down the house.

Gibsonian ecological psychology and the Turvey-Shaw-Mace approach

Gibson's ecological theory of vision (1979) was intended as a direct response to the increasing dominance of computational theories of mind, according to which perception and thought are rule-governed manipulations of internal representations. Gibson's ecological approach to perception has three major tenets. First, perception is direct, which is to say that it does not involve computation or mental representations. That is, Gibson thought that perception was not a matter of internally adding information to sensations. Second, perception is primarily for the guidance of action, and not for action-neutral information gathering. We perceive the environment in order to do things. The third tenet follows from the first two. Because perception does not involve mental addition of information to stimuli, yet is able to guide behavior adaptively, all the information necessary for guiding adaptive behavior must be available in the environment to be perceived. Thus the third tenet of Gibson's ecological approach is that perception is of *affordances*, i.e., directly-perceivable, environmental opportunities for behavior. Affordances, as Gibson was well aware, are ontologically peculiar:

> *[A]n affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer. (Gibson 1979: 129)*

Despite this ontological peculiarity and the controversy over how to best understand affordances (Turvey 1992, Reed 1996, Chemero 2003a, Stoffregen 2003, Scarantino 2004), the idea of affordances —divorced of their relation to direct perception— is the one aspect of Gibson's theory that gained significant attention from the beginning, e.g., from designers (see Norman 1986). The rest of Gibson's ideas were not widely accepted by cognitive scientists upon their appearance. Indeed, as noted above, they were subjected to withering criticism from an establishment in psychology that was committed to understanding perception and

cognition as computational manipulations of internal representations of the environment. The ecological approach was not helped by Gibson's writing style, which, though and highly readable, was often imprecise.

Enter Turvey, Shaw and Mace. Along with a few colleagues, Turvey, Shaw and Mace wrote a series of papers outlining a detailed philosophical account of the ontology and epistemology of Gibson's ecological approach (Shaw and MacIntyre 1974; Mace 1977; Turvey 1977; Turvey and Shaw 1979; Shaw, Turvey and Mace 1980; Turvey, Shaw, Reed and Mace 1981[3]). The most complete and rigorous of these papers is Turvey et al's 1981 reply to criticism from Fodor and Pylyshyn, so I will focus my discussion of the Turvey-Shaw-Mace on this work. The goal of this paper, stated in the first sentence, is to provide a more precise explication of Gibson's work, specifically his claim that "there are ecological laws relating organisms to the affordances of the environment" (Gibson 1979: 237). There are four key notions here, which come in pairs: the first pair is affordance and effectivity; the second is ecological law and information. I will look at them in order, suppressing as much formalism as possible. On the Turvey-Shaw-Mace view, an object X affords an activity Y for an organism Z just in case there are dispositional properties of X that are complemented by dispositional properties of organism Z, and the manifestation of those dispositional properties is the occurrence of activity Y. Conversely, an organism Z can effect the activity Y with respect to object X just in case there are dispositional properties of Z that are complemented by dispositional properties of object X, and the manifestation of those dispositional properties is the occurrence of activity Y. The idea here is that affordances, or opportunities for behavior, are tendencies of things in the environment to support particular behaviors and effectivities are abilities of animals to undertake those behaviors in the right circumstances. Thus, a copy of *Infinite Jest* has the affordance 'climbability' for mice in virtue of certain properties of the book (height, width, stability, etc) and of the mouse (muscle strength, flexibility, leg length, etc.); the mouse has the effectivity 'being-able-to-climb' in virtue of properties of the same properties of the mouse and the book. The dispositional affordance and effectivity complement one another in that the climbing-of-book-by-mouse occurs only when

the climbability and the being-able-to-climb interact. This, according to the Turvey-Shaw-Mace view is what affordances and effectivities are.

To understand how organisms perceive and take advantage of affordance, and, in particular, how they do so directly, Turvey et al define information and natural law. As with affordances and effectivities, the definitions of information and ecological law interact. Ecological laws, according to the Turvey-Shaw-Mace view, are quite different than they are according to what they term the 'establishment/extensional analysis'. Most of the differences don't matter to us here, so I will focus on just one key point of ecological laws: their being bound to contexts. According to Turvey et al, ecological laws are defined only within settings and do not apply universally. Thus, the ecological laws relating to things in the niche of mice do not necessarily hold in outer space, or even in the niches of mackerel or fruit flies. So, instead of taking laws to be universal relationships between properties as the 'establishment/extensional analysis' does, Turvey et al say that properties-in-environments *specify*, or uniquely correspond to, other properties-in-environments. The most important ecological laws on the Turvey-Shaw-Mace view are those relating ambient energy to properties in the environment, e.g., those relating patterns in the optic array to affordances. Thus, in virtue of ecological laws, particular patterns of the ambient optic array specify the presence of affordances in particular environments. It is this specification that allows the arrays to *carry information* about the affordances: because there is a lawful connection between patterns in ambient energy and the properties specified by those patterns, organisms can learn, or be informed about, the properties by sensing the patterns. Of course, among the properties about which information is carried in the array are affordances.

Here's what we have so far: Ecological laws make it such that ambient arrays specify properties (including affordances) and this specification is what makes the arrays carriers of information. The presence of this kind of information underwrites direct perception. If the information required to guide behavior is available in the environment, then organisms can guide their behavior just by picking that information up. Ecological laws guarantee that if a particular pattern is present in

the optic array in a mouse's niche, affordances for climbing by mice are also present. Hence perception of those properties can be direct. This view of direct perception is clearly represented by Shaw's principle of symmetry (Shaw and McIntyre 1974, Turvey 1990). We can represent the symmetry principle as follows. Let E ="The environment is the way it is", I = "The information is the way it is", and P = "Perception is the way it is". Also, let '>' stand for the logical relation of adjunction, a non-transitive conjunction that we can read as "specifies". Then, the symmetry principle is

$$[(E > I) \,\&\, (I > P)] \,\&\, [(P > I) \,\&\, (I > E)].$$

In English, this says that "That the environment is the way it is specifies that information is the way it is and that information is the way it is specifies that perception is the way it is, and that perception is the way it is specifies that the environment is the way it is and that information is the way it is specifies that the environment is the way it is." We can simplify this to say that the environment specifies the information, which specifies perception, and perception specifies the information, which specifies the environment. This principle is symmetrical in that the environment, information and perception determine one another. This, on the Turvey-Shaw-Mace view is what it is for perception to be direct. By law, the environment determines the information, which determines the perception. This makes the perception a guarantee of the presence of the information and also of the environment. So direct perception is perception that, by ecological law, is guaranteed accurate.

Issues with the Turvey-Shaw-Mace approach

The Turvey-Shaw-Mace approach is a sensible and faithful account of an epistemology and ontology to accompany Gibsonian ecological psychology. I think, though, that there are problems with the account. Over the last several years, I have developed an alternative ontological and epistemological background for ecological psychology, one that attempts to be equally faithful to Gibson's vision. Since I have written at length about differences between my views and those of Turvey, Mace and Shaw concerning affordances (Chemero 2003a)[4], I will restrict my comments

here to differences concerning direct perception and information. The main problem with the Turvey-Shaw-Mace account is that, by insisting that information depends upon natural law, they have made it such that there is too little information available for direct perception. In particular, on the Turvey-Shaw-Mace view, there is no information about individuals, in social settings, or in natural language. I will discuss these in order.

On individuals

Because Turvey, Shaw and Mace take direct perception to be infallible, they insist that it be underwritten by information, which is, in turn, underwritten by natural law. They are careful to maintain that the laws in question are *ecological* laws, laws that hold only in particular niches Thus, laws need not be universal in order to allow information to be carried in the environment. But, of course, ecological laws must still be general in that they apply to a variety of individuals. For example, there would be an ecological law that connects a particular optical structure, a visible texture, to the bark of a particular kind of tree: in the environment of gray squirrels, say, optical structure O is present only when light has reflected off a silver maple. Note that making the ecological law niche-specific makes it so that the presence of optical pattern O in other environments, where lighting conditions or tree species differ, doesn't affect O's information carrying in the squirrel's environment. So far so good, but in each gray squirrel's environment there are a few trees that have special affordances in that, unlike most trees in the environment, they contain nests. There are no ecological laws relating these trees, as individuals, to properties of the optic array, so there is no information about these trees, as individuals, available to the squirrels. This, of course, does not apply only to trees. If information depends on laws, there is also no information about individual people available for perception. So although a human infant might have information available about humans, she has none about her mother. So, on the Turvey-Shaw-Mace view, either babies do not perceive their mothers (because the information for direct perception is unavailable) or they do not perceive them

directly. I take it that either alternative is unacceptable to the ecological psychologists.

On social and linguistic information

Another facet of the Turvey-Shaw-Mace requirement of law-like regularities for information to be present is that no information can be carried in virtue of conventions. Conventions hold, when they do, by public agreement or acquiescence and are thus easily violated. Because of an error at the factory or a practical joke a milk carton may not contain milk and a beer may not contain beer. This is true in any context in which milk cartons and beer cans appear. Similarly, through ignorance or dishonesty spoken and written sentences can be false and words can be used to refer to non-standard objects. In fact, these things happen all the time even in the environments where the conventions in question are supposed to be most strongly enforced, e.g., at the grocery store or Presidential press conferences. None of this is to imply that there is no information to be picked up at grocery stores or when the President speaks. Ecological laws determine the way that collections of aluminum cans in a cardboard box will structure fluorescent light and the way exhalations through vocal cords that pass by moving mouth, lips, tongue and teeth will structure the relatively still air. So there is information that there are cans on the shelf and that the President has said the he and Tony Blair use the same toothpaste. But, because these things are merely conventionally determined, and conventions may be violated, there is no information concerning the presence of beer or the President's toothpaste of choice. And since direct perception depends upon the presence of such information, we must, according to the Turvey-Shaw-Mace view, perceive that there is Bodingtons in the cans and that the President and Prime Minister use the same toothpaste either indirectly, or not at all.

I would prefer theories of information and direct perception that allow children to directly perceive their mothers and for beer cans to inform us about the presence of beer. This requires different accounts of what it is for perception to be direct and of the nature of information.

An alternative approach to direct perception

On the Turvey-Shaw-Mace approach, direct perception is defined as perception that is grounded in ecological law, so is always accurate. Indeed, Turvey et al 1981 define *perception itself* as direct and law-governed (Turvey et al 1981: 245). As argued above, this rules out information about, and so direct perception of, individuals and things partly determined by convention. To make it possible for these things to be perceived directly, we need a different understanding of direct perception. In this section, I describe perception as direct when and only when it is non-inferential, where being non-inferential does not guarantee accuracy. Direct perception is perception that does not involve mental representations.

We can get started in seeing what this kind of direct perception is by looking at Brian Cantwell Smith's notions of *effective* and *non-effective tracking*. We can see effective tracking in the shop-worn example of a frog tracking a passing fly. In terms of the physics of the situation, Smith points out, what we have is a continuously moving column of disturbance, beginning at the fly and ending at the frog. The key here is that this column-shaped disturbance is *just one thing*, and is not separable into frog, fly and intervening atmosphere, at least not in terms of physics. When a frog tracks a fly in this way, the frog and fly are coupled in a very strong sense: they are not separate things. The key for our purposes is that the tracking is a matter of constant causal connection among frog, fly and intervening air. This involves nothing worth calling a mental representation: in effective tracking, any internal parts of the agent that one might call representations are causally coupled with their targets. This effective tracking is direct perception. We can also have direct perception during *non-effective tracking*. Often an animal must continue to track an object despite disruption of causal connection. The frog, that is, must be able to continue to track the fly even when the light reflected from it is (temporarily) occluded. Frogs probably are not capable of this, and indeed it is hard to imagine something coming between a frog and a fly at a tongue-reachable distance. But this kind of non-effective tracking is the norm in vigilance in the animal kingdom. A nesting bird doesn't lose track of the fox that is temporarily behind a rock. Non-effective tracking, though, also does not require mental

representation. There are three reasons for this. First, non-effective tracking could be accomplished just by causal connection and momentum. The head's momentum keeps it going that way, and the bird's eyes meet up with the light that is no longer occluded by the rock. Second, as Gibson points out, perception is an activity, and as such happens over time. So directly perceiving something may involve periods of time when it is being tracked effectively and periods when it is tracked non-effectively. Third, and this is getting ahead of myself because I haven't said what information is yet, there is still information in the light about something that is temporarily occluded. Thus we can have direct, that is non-representational, perception even when tracking is non-effective.[5]

There are two relevant consequences of taking tracking as the model of direct perception. First, we can see that perception is, by definition, direct. Perception is always a matter of tracking something that is present in the environment. Because animals are coupled to the perceived when they track it, there is never need to call upon representations during tracking. Effective and non-effective tracking are non-representational, hence direct. Acts of *conception*, which Smith calls *registration*, may require representations. In conception or registration, there is a distancing and abstraction. It requires *detachment* in that the subject must "let go" of the object, stop tracking it (even non-effectively) for a while. The difference here is like that between knowing your nephew will come out from under the other side of the table, and knowing that you won't see him again until next Thanksgiving. This latter requires *abstraction* in that the subject must ignore many of the details of the object to keep track of it. When you're effectively or non-effectively tracking your nephew, you are coupled with every detail of him: every freckle, individual hair, and shirt-wrinkle is moving in concert with your head and eyes. When this physical connection is broken completely, you lose or abstract away from much of this detail. This, it seems, will require something like a representation. But direct perception never does.

The second consequence of taking tracking as the model of direct perception is that perception can be direct and mistaken. First, and perhaps obviously, when tracking is non-effective, it is possible for the animal to lose track of its object. The

fox might stop behind the rock, yet the bird's head and eyes might keep moving along the path that the fox was following. This kind of minor error is typically easily corrected, of course. Another possibility is when an animal is coupled with an inappropriate object. For example, the same optical pattern can be caused by a full moon and a light bulb on a cloudy night. And there will be the same sort of continuous column of disturbance connecting a moth to each. So the moth will be effectively tracking whichever of the two it happens to be connected with. When the moth is effectively tracking the light bulb, it is making a mistake. But this does not mean that it is tracking the bulb via a mental representation of the moon. For if it did, then it would also be tracking the moon via a mental representation of the moon when it was doing things correctly and perception would never be direct. Instead, the moth is directly perceiving the moon or misperceiving the light bulb via what Withagen (2004) calls a non-specifying optical variable. A variable is non-specifying when its presence is not one-one correlated with some object in the environment. Withagen argues that, like the moth when it is coupled with the moon, many animals rely on non-specifying variables. Yet according to the Turvey-Shaw-Mace view, non-specifying variables do not carry information about the environment, and so cannot be used for perception, direct or otherwise. So to make sense of the moth's effective coupling with the moon as a case of direct perception, we need a different theory of information, according to which non-specifying variables can carry information. (The same is true if we want to understand my perception of beer-presence in beer cans and meanings in words.)

An alternative approach to information

There is a theory of information that has considerable currency in cognitive science that is consistent with Gibsonian information: Barwise and Perry's (1981, 1983) *situation semantics*, and the extensions of it by Israel and Perry (1990), Devlin (1991), and Barwise and Seligman (1997). Situation semantics is a good candidate here because Barwise and Perry's realism about information was directly influenced by Gibson. Barwise and Perry (1981, 1983) developed situation semantics in order to, as they said, bring ontology back to semantics. That is, they were interested in a

semantics based on how the world is, and not on minds, knowledge, mental representations, or anything else epistemic in character. Information, according to this view, is a part of the natural world, there to be exploited by animals, though it exists whether or not any animals actually do exploit it. According to situation semantics, information exists in *situations*, which are roughly local, incomplete possible worlds. Suppose we have situation token s1 which of type S1 and situation token s2 which is of type S2. Then situation token s1 carries information about situation token s2 just in case there is some *constraint* linking the type S2 to the type S1. Constraints are connections between situation types (figure 1).

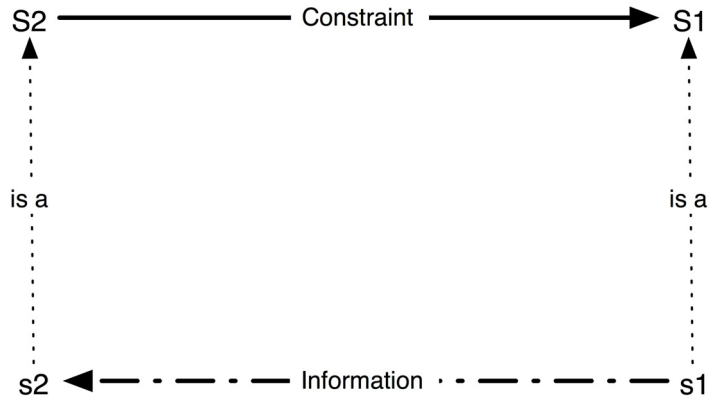

Figure 1. Situation token s1 carries information about s2 while there is a constraint linking type S1 to type S2.

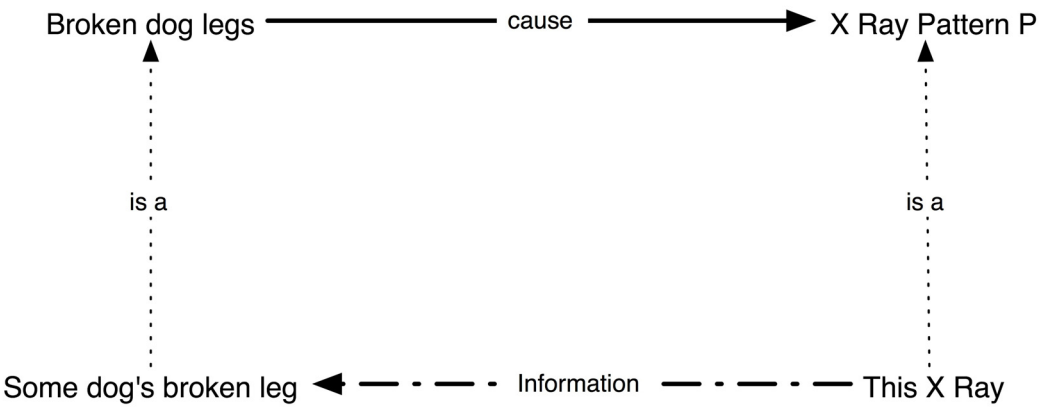

Figure 2. A classic situation semantics example.

To use the classic situation semantics example (Barwise and Perry 1983, Israel and Perry 1990, Barwise and Seligman 1994), consider the set of all situations of type X, in which there is an x-ray with a pattern of type P. Because patterns of type P on x-

rays are caused by veterinarians taking x-rays of dogs with broken legs, there will be a constraint connecting situations of type X with situations of type D, those in which there is a dog with a broken leg that visits a veterinarian. Given this, the fact that a situation x is of type X carries the information that there is a situation d (possibly identical to x) of type D in which some dog has a broken leg (figure 2).

For our purposes here, there are two things to note about this example. First, the constraint between the situation types is doing all the work. That is, the information that exists in the environment exists because of the constraint, and for some animal to use the information the animal must be aware of the constraint. This feature is true not just of the example of the unfortunate dog, but holds generally of information in situation semantics. The second point is that the constraint in the example holds because of a causal regularity that holds among dog bones, x-ray machines and x-rays. That is, the particular x-ray bears the information about the particular dog's leg because, given the laws of nature and the way x-ray machines are designed, broken dog legs *cause* x-rays with patterns of type P. This feature of the example does *not* hold more generally of information in situation semantics. That is, constraints that hold between situation types are not just law-governed, causal connections. Constraints can hold because of natural laws, conventions, and other regularities. So, a situation with smoke of a particular type can bear information about the existence of fire by natural law, but it can also bear information about the decisions of tribal elders by conventions governing the semantics of smoke signals.

Even given this very sketchy description of the nature of information in situation semantics, we can see that this view of information can capture the kind of information that Gibson was interested in. We can see this via an example. Imagine that there is a beer can on a table in a room that is brightly lit from an overhead source. Light from the source will reflect off the beer can (some directly from the overhead source, some that has already been reflected of other surfaces in the room). At any point in the room at which there is an uninterrupted path from the beer can, there will be light that has reflected off the beer can. Because of the natural laws governing the reflection of light off surfaces of particular textures,

colors and chemical makeup, the light at any such point will be structured in a very particular way by its having reflected off the beer can. In situation s1, the light a point p has structure of type A. Given the laws just mentioned, there is a constraint connecting the situations with light-structure type A to the beer-can-present situations of type B. So, the light structure at point p contains information about situation about token beer-can-presence b (of type B). Notice too that, because of conventional constraints governing the relationship between cans and their contents, beer-can-presence b being of type B carries information about beer-presence c of type C. Furthermore, the light at some point in the room from which the beer can is visible will contain information about the beer can's affordances. Take some point p, which is at my eye height. The light structure available at this point will contain not just information about the beer can and the beer, but also about the distance the point is from the ground, the relationship between that distance and the distance the beer can is from the ground, hence the reachability of the beer can and drinkability of the beer for a person with eyes at that height.

Note that this example makes clear that on my view, but not Turvey-Shaw-Mace's, constraints that connect situations are not limited to law-like connections but can also be cultural or conventional in nature. The fact that some situation token contains information about some other token does not necessarily entail that the second situation token is factual. For example, the light at my point of observation contains information about the beer can and the beer can contains information about beer being present. If it's possible that, because of some error at the bottling plant that caused the can to be filled with water, there is no beer in the can, the beer can presence can still carry information about beer presence. But according to Turvey-Shaw-Mace, the connection between the states of affairs must be governed by natural law. So according to the Turvey-Shaw-Mace view, beer can presences don't carry information about beer presences, and this is because the beer can is not connected by natural law with the presence of beer. This is also a feature of Dretske's theory of information (1981) and has long been thought to be problematic.[6]

Situation theorists have typically argued that constraints need not be law-like connections between situation types. Barwise and Seligman (1994, 1997) for example have argued that the regularities that allow the flow of information must be reliable, but must also allow for exceptions. Millikan (2000) makes a similar point. She distinguishes between informationL (information carried in virtue of natural law) and informationC (information carried in virtue of correlation). Because constraints need only be reliable, and not law-like, non-specifying variables can carry information. Millikan also makes a valuable point concerning just how reliable non-specifying variables need be. On her teleosemantic view, the correlation between two events needs to be just reliable so that some animal can use it to guide its behavior. Thus, information-carrying connections between variables can be fully-specifying, marginally significant, or anything in between, depending on the type of behavior that the variable provides information for.

This works well with the theory of what it is for perception to be direct, outlined in section 3 above. Remember that, according to this view, perception is direct when it is non-representational, the result of an informational coupling between perceiver and perceived. This says nothing about what kind of constraint allows the information to be available. Since the situation semantics theory of information allows information to be present with merely reliable constraints, constraints that hold only sometimes can underwrite direct perception. So we *can* directly perceive beer-presence, given beer-can presence despite occasional mix-ups at the factory. And we can directly perceive the meaning in the spoken sentences despite the fact that people lie or misspeak. Most importantly, I think, a developing child can directly perceive her mother, even though there are no laws of nature concerning individuals.

Compare and contrast: on specification and symmetry

I have already said that on the views of information and direct perception outlined here, there is information about, and so the possibility of direct perception of, individuals and socially-, culturally-, and conventionally-determined entities and states of affairs. This is already a marked difference between the view I outline and

the Turvey-Shaw-Mace view. Even more striking, and perhaps more troubling to some ecological psychologists, is the effect the views I have outlined have on Shaw's principle of symmetry. Remember that the principle of symmetry is that (1) the environment specifies the information available for perception and that the information available for perception specifies what is perceived and (2) what is perceived specifies the information available for perception and that the information available for perception specifies the environment. There are, in other words, 1:1 correspondences between the environment and the information available for perception and between the information available for perception and what is perceived. This principle is, perhaps, the most important part of the Turvey-Shaw-Mace view of information and direct perception. Indeed as was noted above, information and direct perception are defined in terms of it. On the view described here, however, symmetry is not true. This is the case because on my situation-semantics-derived view, information does not depend on 1:1 correspondences. To repeat the example, on my view, there could be information about beer at my point of observation because light arriving there has been reflected off an unopened Bodington's can, but there may actually be no beer because the can might be full of something else. In fact, according to the view I've outlined, there is an important asymmetry at work here. The asymmetry in question here is partly an asymmetry in what we might call direction of it. The environment to perception fit is, at least partly, causal, while the perception to environment fit is primarily normative. The can being the way it is causes the light to be the way it is at my point of observation, which sometimes causes me to perceive the beer in the refrigerator. But my perception, via the structure of the light, that there is beer in the refrigerator in no way causes there to be beer in the refrigerator. Instead, my perception fails, is incorrect, if there is no beer.

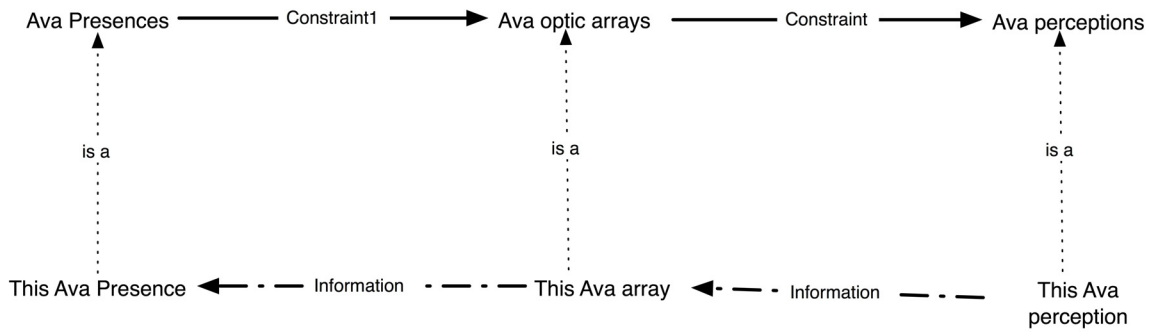

Figure 3. The top part of the diagram is analogous to Shaw's E > I > P; the bottom is analogous to his P > I > E.

A second way the asymmetry of direction of fit shows up can be brought to light diagrammatically. In situation semantics, constraints connecting types of situations allow tokens of those types to carry information. So for example, because of various constraints concerning the way light reflects off surfaces, there are causal constraints connecting the type of situation in which my daughter is present to situations in which the optic array is structured in a particular way, and because of the way light interacts with me and my visual system, there will be constraints connecting these optical array structurings and my perception of my daughter. That is, constraint C1 connects Ava-present situation type E with Ava-array situation type A and constraint C2 connects Ava-array situation type A with Ava-perception situation type P. Constraints C1 and C2 are, of course, primarily causal. We can see this in the top part of Figure 3. This part of the figure, and this direction of fit from environment to perception, corresponds to the first part of the symmetry principle, E > I > P. In contrast, consider the lower part of Figure 3. This depicts the relationship among tokens: this particular Ava-perception token p of type P is informative about a particular Ava-array token a of type A which is, in turn, informative about a particular Ava-presence token e of type E. This reflects a truism of situation theory: information "flows" among tokens in virtue of constraints among types. This lower part of the diagram corresponds to the second part of the symmetry principle, P > I > E. We can, then, see another way in which the different directions of fit are different: the environment to perception direction of fit is due to constraints among types and the perception to environment direction of fit is due to an informational relationship among tokens. On this view, Shaw and

MacIntyre were right that there is a two-way informational relationship between perception and the environment, but they were wrong in thinking that both directions of the relationship are the same.

Final words

In this paper, I have offered understandings of direct perception and information that differ from the ecological psychology orthodoxy, the Turvey-Shaw-Mace view. While their view takes perception to be direct when it is necessarily correct, on the view I have outlined, perception is direct when the perceiver and perceived are coupled and their relationship is unmediated by mental representations. While their view takes information to depend upon ecological laws and fully-specifying variables, my view takes information to depend upon constraints that may be only partly-specifying. I hope that I have said enough to make it clear that my alternative views comprise a coherent and attractive option for those interested in the ecological approach to psychology and those interested in embodied cognitive science. Indeed, I have argued elsewhere that the theory of information found in situation semantics ought to be appropriate for everyone in the cognitive and computing sciences. I have, of course, said nothing that makes the Turvey-Shaw-Mace orthodox view incoherent, though some of my arguments should make it less attractive.

Notes

1. For a representative sample, see (Port & van Gelder, 1995).
2. I should also point out that I owe them a personal debt. Though I was never formally a student of Shaw, Turvey, or Mace, each has been patient corrector of my misinterpretations and has even encouraged me in the development of my competing views. They still think that I'm wrong.
3. A quick note on Edward Reed: Although Reed was an author on the paper on cognition and spent his career working on a philosophically-sound version of Gibson's ecological psychology, I think it makes more sense to speak of the Turvey-Shaw-Mace view and not the 'Turvey-Shaw-Reed-Mace view'. This is because after working on the 1981 paper, Reed developed views that diverged both from that presented in the 1981 paper and from the one I'm presenting here.

4. Furthermore, Michael Turvey and I have recently come to think that the differences between our views of affordances are actually more similar than meets the eye. See Chemero and Turvey, in progress.
5. I should point out that there are some who would argue that there are mental representations involved, even in effective tracking. I have written about this at length elsewhere (Chemero 2000, 2001) and will not repeat myself here other than to say that during tracking claiming that some part of an animal represents some part of the environment provides no explanatory purchase. That is, it is only possible to pick out the part of the animal that is the representation once one already understands the system as a causally connected whole.
6. Note that everything said here about Turvey-Shaw-Mace is also true of Dretske's classic probability-based theory of information (1981).

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