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THE MINIMALIST REPRESENTATIONALISM OF THE ECOLOGICAL THEORY OF PERCEPTION

The aim of the article is to consider the possibilities of incorporating the category of mental representation into the ecological theory of perception, devised by its originator, James J. Gibson, as a kind of antirepresentationalism. The full-blooded idea of perceptual representation seems "too heavy" for the needs of the ecological approach, according to which perception consists in directly collecting or apprehending the features of objects present in the environment by means of the senses. Since this process is a direct one, Gibson believes postulating mental representation does not in any way make it easier to understanding it. On the other hand, in contemporary philosophy of mind and cognitive psychology the concept of mental representation is almost indispensable. The article presents an attempt to interpret the perceptual process of information acquisition in terms of dynamic systems theory – or, more precisely, as a kind of simulation. The simulation model of perception based on a minimalist understanding of representation (as procedural knowledge) is meant to complement the ecological theory of perception proposed by Gibson.

Keywords: ecological theory of perception, James J. Gibson, perception, simulation, representation, minimalist representationalism, dynamic models.

The ecological theory of perception emerged in its final shape in the 1970s, put forward by an American psychologist James J. Gibson. According to it, perception does not consist in the reproduction of reality by the senses based on sensory experiences or impressions. Moreover, for Gibson, perception does not issue in mental representations, conceived as some kind of mental counterparts of perceived objects and their properties. The perceiving subject has rather to grasp directly, or pick up, information about the way the world is.[1]

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[1] For a detailed discussion of the development of the Gibsonian approach to perception and its constitutive conceptions, see Schetz, 2012.

Of course, an approach of this kind has its own difficulties. The most evident one is related to antirepresentationalism, distinctive for the ecological approach. It seems that forfeiting the category of mental representations is a much more demanding methodological move than the common strategy known from the representationalist approach. It is true that recent accounts of perception are often based on the category of information rather than on the idea of traditionally conceived representation, yet the mutual relationships between those two categories are not ultimately settled. Hence it is still possible that informational conceptions of perception are, as a matter of fact, a slightly modified and to some extent updated version of representationalism. Representationalism is, then, considered as a research attitude or stance – which is, in fact, in concord with the main bottom line of this paper. This attitude amounts to the belief that perception consists in giving meanings to perceived objects, or grasping the meanings that these objects possess for the perceiving subject in her environment. Perception is, then, a distinctively intentional state; each of its objects is perceived in a particular way; for instance, a hollow in a tree is perceived differently by a hunting cat and differently by a bird searching for a nesting place. One might say that the perceptual representation of a hollow in the case of a cat is different from the way in which the hollow is represented by a bird, even if one is an advocate of the informational approach to perception.[2]

The aim of this paper is to consider and assess the possibility of including the category of mental representation within the ecological theory of perception. Although efforts of this kind have already been made in the philosophy of perception,[3] it is far from clear what construal of the category of representation is involved there. The paper will attempt to show that no crucial harm is being done to the ecological theory of perception when it is tied up with the minimalistically construed category of perceptual representation – that is, representation conceived along the lines of procedural knowledge. Eventually, an argument will be advanced to the effect that the ecological theory of perception, if it is to be in concord with recent representationalism in the psychology and philosophy of perception, should be interpreted as a simulation theory.

[2] In other words, representationalist and informational approaches are not necessarily mutually exclusive.

[3] See, for example, the following works in philosophy and cognitive science: Varela, Thompson, and Rosch, 1991; Noë, 2004; Thompson, 2007. Their authors do not explicitly modify the ecological theory of perception. They are rather interested in advancing perception theories of their own. However, their views are intended to overlap and coincide in many respects with the Gibsonian project of the ecological theory of perception.

The structure of the paper is as follows. In its first part, the most important claims and arguments for the ecological approach to perception are briefly presented. In the second part, the main kinds of mental representations are specified and described. The third part discusses the so-called overintellectualization of perception problem, which consists in imposing too stringent constraints on the notion of perceptual knowledge in order to make it still legitimate to speak of minimalistically conceived representation. In the concluding part, two cases of the simulation approach being deployed in developmental psychology are scrutinized. By analogy, solutions based on it may be used in the theory of perception.

THE ECOLOGICAL THEORY OF PERCEPTION

The ecological theory of perception, formulated in its mature form, may be described by reference to three ideas:

(1) Action does not amount to a reaction to a particular, individual, and isolated stimulus,but it is rather a response to stimulus variables or to generally understood stimulation.

(2) The contents of perceptual experience and of its vehicle should be located in the environment of the perceiving subject, not within the subject's structure (in her brain, her mind, or their arbitrary counterpart).

(3) Perceptual attention participates in a significant way in the constitution of perceptual experience.

All these ideas seem to provide foundations for the Gibsonian criticism directed against behaviorism. One might also suppose that this criticism is in the first instance engendered by the opposition to the ubiquitous tendency to reduce psychological states and processes, such as emotions, feelings, reasoning, memory, and many others, to physiological states and processes. In the preface to his famous book, *The Ecological Approach to Visual Perception*, Gibson writes:

> Vision is a strange and wonderful business. I have been puzzling over its perplexities for 50 years. I used to suppose that the way to understand it was to learn what is accepted as true about the physics of light and the retinal image, to master the anatomy and physiology of the eye and the brain, and then to put it together into a theory of perception that could be tested by experiments. But the more I learned about physics, optics, anatomy, and visual physiology, the deeper the puzzles got. The experts in these sciences seemed confident that they could clear up the mysteries of vision eventually but only, I decided, because they had no real grasp of the perplexities.

> Optical scientists, it appeared, knew about light as radiation but not about light considered as illumination. Anatomists knew about the eye as an organ but not about what it can do. Physiologists knew about the nerve cells in the retina and how they work but not how the visual system works. What they knew did not seem to be relevant. They could create holograms, prescribe spectacles, and cure diseases of the eye, and these are splendid accomplishments, but they could not explain vision.
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> Physics, optics, anatomy, and physiology describe facts, but not facts at a level appropriate for the study of perception. . . . I attempt a new level of description. It will be unfamiliar, and it is not fully developed, but it provides a fresh approach where the old perplexities do not block the way (Gibson, 1979/1986, p. xiii).

These incisive words express very well the bottom line of a new approach to perception, advertised by Gibson. To complete the picture, it will be worth invoking an example. Gibson was concerned not only with a general explanation of the phenomenon of vision, or perception in general, but also with plenty of detailed or particular problems. One of them was the phenomenon of a blind spot. Behaviorists, at least as Gibson understood them, were unable to answer the question of how it happens that, in reaction to a stimulus indicating a gap in the center of the vision field, the subject does not show in her behavior that she sees the gap. It is worthy of notice that the case of a blind spot is troublesome for behaviorists in two ways. First, they have to explain why, following a stimulus with a lack of some information near the center of the visual scene, one should expect a reaction in the form of a behavior disregarding the fact of this lack. Second, to explain the previous thing, one needs sooner or later to appeal to a visual impression or sensation in which there is no trace of the relevant lack in the center of the field. It goes without saying that these categories have not been met with approval by behaviorists. Gibson discusses neither these problems nor the possible strategies behaviorists might adopt in order to resolve them. Taking for granted that every approach to the phenomenon of perception which relies on reduction is doomed to failure, he delineates his own proposal of explaining the lack of the blind spot effect. Usually, the fact that perceiving subjects do not notice any gaps in their visual fields that apparently should be the effect of the lack of receptors in the area of the blind spot is explained in terms of "the filling-in mechanism." No matter what the detailed account of this mechanism is, the underlying principle is always the same: the brain completes the lacking information using that information which is in its possession. For instance, in binocular vision, the information gathered from the left eye would provide the grounds to complete a blind spot in the visual field of the right eye, and vice versa. And in the case of monocular vision it is generally suggested that the picture involved is completed by reference to the previously known patterns.

First and foremost, Gibson argues against the practice of invoking merely the filling-in mechanism (Gibson, 1979/1986, p. 204). He says that a blind spot does not bring about the impression of lack in the visual scene, since no informational lack can be found here. First of all, the eye makes saccadic movements, and that constantly causes corrections of retina stimulation by photons. One can say that "underinformed" areas are almost immediately "corrected" in subsequent saccades. This is how – Gibson might exult – the dynamics of vision prevails over the physiology of vision. Moreover, contrary to Jerome S. Bruner's standards of explaining normal perception phenomena in the light of findings concerning distorted perception, for instance illusions, Gibson calls into question the thesis that we experience the effect of a blind spot at all. If anyone can claim to have had such an experience, then it must have happened merely in an artificial experimental setting, when a special task was set. In natural circumstances, the blind spot effect does not occur. Why? Due to the nature of perception. As Gibson emphasizes, a distinctively structured stream of light[4] – or, briefly, an optic array[5] – does not carry with it the information that something is missing in the center of the visual field. A stimulus impinging on eye receptors does not constitute a single area, detached from the environment. One should rather speak here about stimulus variables of an optic array (Gibson, 1961/1982, p. 67). Reference to stimulus variables of light brings particular physical variables to Gibson's mind: wave length, intensity, or quantum of energy. However, Gibson notices that the approach to the nature of light presupposed here relies upon the idea of a beam of light. Yet, ecologically construed perception is tied up with the description of light as the bearer of information. Information carried by an optic array may be given to the subject of perception in an actual or potential way. For instance, a white wall lit by yellow light can still constitute the bearer of potential information for the perceiving subject that it is white, not yellow. The informational nature of an optic, or perceptual, array is understood by Gibson as some correspondence between the structure of light propagating around the perceiving subject and environmental facts: surfaces, edges, occlusions, events, places, etc. (Gibson, 1961/1982, p. 69). One can say that the geometry of vision is different from the geometry of physicists (Gibson, 1961/1982, p. 57). Here – Gibson might exult again – the ecology of vision decisively defeats physics.

The geometry of vision is not in conspicuous discrepancy with mathematical geometry. As Gibson emphasizes, their mutual connections are simply not clear

[4] See Uchnast, 1994, p. 65.

[5] See, for example, Maruszewski, 2001, p. 70.

enough. Nevertheless, it is possible to formulate the following principles describing the ecological geometry of vision (Gibson, 1961/1982, pp. 57-59):

(1) Presence or absence of texture: "A homogeneous region of the optic array corresponds to an unobstructed medium of air; a textured region of the array corresponds to a relatively solid surface. The former is perceived by us as a filmy or unsubstantial color; the latter as a surface color."

(2) Pattern or form of a texture: "[F]orm of an optical texture: it is invariant, as the geometer says, under a transformation. For example, if two textures, one composed of triangles and the other of rectangles, both underwent magnification or perspective foreshortening they would still be composed of triangles and rectangles respectively. Another important fact about the form of a texture is that it stays constant when the intensity of the light is altered. The structure of an optic array, that is, is independent of the energy level of the array."

(3) Texture with a closed contour: "A cone of the optic array with internal texture and a sharp boundary corresponds to a solid detached object in the environment. Such a bounded region of the visual field, without reference to texture, has been said to induce the figure-ground phenomenon in perception. But note the following. A cone of the optic array with a sharp boundary but *without* internal texture corresponds to a hole in the environment, such as the mouth of a cave or a window on the sky. To this stimulus, the phenomenal properties of the figure-ground phenomenon do not apply. . . . One may conclude from this that contour and texture are not separate and independent stimuli in the world (we have only made them so artificially in outline drawings) and that these two properties of light are informative only in combination. These considerations lead me to suspect that object-perception and its complement 'hole-perception' are not based on figure-ground perception as we have supposed but are, on the contrary, simpler and more direct."

(4) Shape and size of contour as an abstract form: "The shape of a closed contour without motion or texture does not specify the shape of an object in the environment. It is only ambiguous information. . . . This, together with the other cues, is in truth only a probabilistic indicator of the environmental surfaces. . . . If we had considered the structure of a natural optical array, which consist of forms *within* forms, we should not have been driven to the theory of the cues or clues for space perception, nor lead to the theory of the figure-ground phenomenon as an improvement on it."

(5) Density of texture itself: "The compactness of an optical texture in itself is ambiguous . . . . If the parallax at the edge is covariant with kinaesthetic stimu-

li from movement of the head and body the information about a solid environment becomes as statistically reliable as anyone could hope for."

(6) Transformation: "A transformation of the pattern of an optic array, both the hole and all its parts, corresponds to a change of the station-point, that is, to a change in the animal's point of view. . . . [C]hanges of form and texture . . . are in fact the best information obtainable about objects. A family of transformations over time, I suggest, should be considered as stimulus for an eye. A change of pattern is optically just as much a fact as a nonchange of pattern, and there is no good reason to assume that eyes register unchanging pattern as a primary process, and change as a secondary process."

(7) Invariant properties: "What I have called the pattern or form of a texture is the same in all its perspectives. Each perspective is transformation of what it would be if the station-point were different. The gradient of the spacing or density of the texture will differ, for example. But it is the same texture. Most generally, the adjacent order of texture-elements is preserved in any projection; only the distances and angles between elements are altered."

As is clear from this short presentation of principles distinguished by Gibson, the relationships between ecological geometry and the geometry postulated by the Gestalt psychologists are far from obvious as well. Principles (3) and (4) state that fact explicitly. Gibson agrees with the tenet of the Gestalt psychologists to the effect that in order to speak about visual perception of an object at all it is necessary to abandon completely the empiricist assumption that what is primarily given to a perceiving subject are sense impressions such as color patches, lines, or simply various illuminations of objects' surfaces, and that the unified and relatively constant field of vision is the result of the deployment of association laws to the flow of particular stimuli from the environment. The subject of disagreement between proponents of ecological geometry and advocates of the geometry generated by the Gestalt theorists would be the phenomenology of vision. In a similar vein to Gibson, the latter invoke, while arguing against the empiricist model of perception, the data available to the perceiving subject. Nevertheless, they do not focus their attention on the order of stages in the processing of perceptual information by the visual system. Even if the eye follows, for example, first the vertices of a two-dimensional rectangular figure and subsequently its sides and diagonals, this is not the kind of process of which we are aware and which we register. We see a rectangle as a ready-made whole. The visual phenomenology – that which we see – is simply different from ways of seeing – from how we see.

Nonetheless, the agreement between Gibson and the Gestalt theorists comes to an end with this claim. As principle (4) says, the latter merely speak about some abstract form of the visual field, not what we actually see. A contour separating a given texture from another one is, as Gibson teaches us, simply a projection of our imagination. The shape of a closed contour, taken in itself, constitutes at the very most a probable indicator of the fact that there is a solid surface in the environment.

One should consider very intriguing the attempt at an analysis of perceiving "lacks" in a surface, that is, of seeing holes, suggested in principle (3). Gibson notices that if the phenomenology of vision were consonant with the description of it given by proponents of the Gestalt school, then a hole in the middle of some surface – the lack of texture within a particular texture – should be taken as an act of seeing an object on a given background. However, if we include a motor factor in the case under consideration, then the perception of "lacks" becomes fully intelligible. Visual stimuli flowing in from the environment undergo changes, while at the same time having some invariant properties, relative to the observer's movements. The shape seen from different perspectives turns out to be a lack, not the filling-in of a certain piece of surface reflecting light. The perception of lacks in the surface of an object is possible, since what determines the phenomenology of vision is not single stimuli from the environment (as envisaged by empiricists), and not even those stimuli taken as a whole in a given situation (as endorsed by the Gestalt theorists), but an invariant optic array. In other words, the decisive factor here is a structured beam of light, indispensably connected with the observer's point of view and movements. This means that the phenomenology of vision is constituted by sensorimotor information.[6]

Let us consider now whether the phenomenology of vision, accounted for in these dynamic terms, can be supplemented with the category of perceptual representation.

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[6] Sensorimotor approaches to perception are currently in vogue. Many thinkers combine them with the idea of so-called embodied perception, rooted in the ecological theory of perception. Recent advocates of those approaches include Alvin Noë (2004), Evan Thompson (2007), and Anthony Chemero (2009). One should also consult collections devoted to embodied cognition and so-called situated cognition. See, for example, Robbins and Aydede (Eds.), 2009, and Klatzky, MacWhinney, and Behrmann, 2008.

MENTAL REPRESENTATIONS[7]

The category of **pictorial representation**, well-known and alive in psychology today, seems to accord perfectly with theories of perception. Linking perception with the creation and processing of some kind of mental pictures or images by a perceiving subject is not only intuitive but also allows us, without too much trouble and investment, to describe the similarity between how one sees and what one sees. The analog structure of pictorial representation is called into question by advocates of **propositional representations**, considered as better candidates to be included in the adequate description of the phenomenology of visual perception. As a matter of fact, we do have a strong conviction that what we really see are some mental images, but many experiments appear to show that this is simply not true (see, for example, Nęcka, Orzechowski, & Szymura, 2006, or Cooper & Shepard, 1973). The pictorial theory itself is based merely on the hypothesis about the functional equivalence between perception and imagination (see Kosslyn, 1975, and – for criticism – Marmor & Zaback, 1976). In fact, an act of perception would consist in forming particular beliefs about the perceived object.

The competition, as one might put it, between these two groups of psychologists of perception is avoided by a theory ingeniously combining these two approaches, namely pictorial and propositional (see Paivio, 1971). **The dual coding theory** describes perception as some sort of exchange of information between two systems equal in their cognitive significance: verbal and nonverbal. Logogens, taken as elementary constituents of the former system, are the result of coding of information from three sensory channels: visual, auditory, and tactual; correspondingly to the kinds of senses mentioned here, they are embedded in three subsystems of the verbal system. On the other hand, the nonverbal system, populated by imagens, consists of five sensory modalities. Within each of the two systems there are association processes, and between them – that is, between the verbal system and the nonverbal one – referential and representational processes occur (Paivio, 1971; Nęcka, Orzechowski, & Szymura, 2006, p. 81). An interesting feature of the dual coding is assigning the recognition of linear order in the environment to associative functions occurring in the nonverbal sys-

[7] This section provides a very sketchy outline of the main theories of mental representation. For reason of brevity, I ignore such approaches that, in the account of information processing, emphasize the role of levels of consciousness – that is, theories advocated, for instance, by David Chalmers, Peter Carruthers, and David Rosenthal. Readers interested in those approaches are referred to the collection edited by Velmans and Schneider (2007).

tem; moreover, the associative mode of functioning of the verbal system is taken as responsible for linking objects.

These three key models of perception differ between themselves mainly in the way of conceiving how the format or form of representation is realized. By the form one should understand here the structure taken by the content of a given piece of information. In the case of mental images, the form is **analog** in its character. Hence it is possible to say that the decisive factor in making a given state a representation of some particular object is the similarity between the state and the object. On the other hand, proponents of the propositional approach insist upon giving up ordinary or common intuitions that lead to endorsing the category of mental images. According to them the true nature of perceptual representations is revealed in an analysis of their **linguistic** form. This means one should abandon any comparisons between representations and represented objects in respect of features shared by both and rather attempt to single out a causal relation that is constitutive of the representational character of representations. If thinking along these lines is correct, then the fact that some particular object or state of affairs in the world, for example a green apple, has brought about or caused in a given subject the belief that, say, this apple is green, entitles one to ascribe to that subject the possession of a representation of some particular green apple. It is not essential here whether an analog copy of an apple has been created in the subject's mind – as advocates of the pictorial theory continue to claim – and whether it is sufficiently similar to the original apple.

Although it might seem that the dual coding theory makes use of a mixture of these two approaches, it is indeed so that within its framework the primary status of information is far from obvious. Since information may be coded in two ways, then either it is possible to change its original format (for instance the initially pictorial format is transformed into the propositional form and vice versa), or information in its original shape does not have a form construed in an analog or propositional way. Eventually, one can even admit that, in general, it is devoid of format as such. Irrespective of the endorsed option, one should be aware of the difficulties it generates.

Putting aside the hopes that perhaps each of these views on the nature of mental representation triggers, one should emphasize that the main hindrance for the ecological theory of perception is its constant struggle – which clearly emerges from tracing Gibson's constant complaints – with the persistent or, as we can even say, pointedly systematic neglect by the proponents of these approaches to consider the conspicuous fact that perception is not a process that consists in a manipulation of any representations. When someone reliably claims that she sees a green apple on the table before her, then the object of her perception is a green apple placed on the table before her, not an intermediary taking the form of a mental image or a proposition. To use the language of philosophers, Gibson defends direct realism, also known as naïve realism.[8]

It is not surprising, then, that the fact of perceiving objects always in a particular way – that is, their perception as being such and such – is explained by Gibson in consonance with the spirit of antirepresentationalism. Perception is aspectual in its nature. Supporting his view with the words of a philosopher who, in the first half of the twentieth century, studied perception very intensely, one could say that we are always on this or that side of an object and that we are never able to perceive it simultaneously in its entirety (Merleau-Ponty, 1962).[9] However, the question arises if, while considering situations in which someone, say, hears given sounds as the *Jupiter Symphony*, composed by Mozart, or sees a green apple as inedible, one may still speak merely about an aspectual grasp of the object of perception? It is arguable that the role of top-down cognitive factors necessitates the use of the category of representation, for instance representations of sounds as a particular symphony and a representation of an apple as sour.

These issues lead to the next one, more fundamental and more general – namely, to the question concerning the relationship between knowledge and perception. The following section will be an attempt to find an answer to it.

THE PROBLEM OF OVERINTELLECTUALIZATION OF PERCEPTION

If the program of combining the ecological theory of perception with the category of mental representation is to be taken seriously, then it appears that the notion best tailored to our needs is that of procedural knowledge. As opposed to mental images and propositional contents connected with linguistic competence, procedural knowledge requires merely application, namely, practical deployment in certain circumstances of a sequence of movements or actions of which the acting subject may be unaware and of which she does not have a conception (that is, descriptive knowledge concerning their nature and properties). "Merely application" is nevertheless "more than enough" in the case of the requirements set up

[8] This train of thought is clearly visible in the collection of Gibson's papers edited by E. Reed and R. Jones (Gibson, 1982).

[9] Of course, similar views had been formulated earlier, for example by Edmund Husserl or by the Polish phenomenologist Roman Ingarden.

by Gibson for the theory of perception. “Merely,” since procedural knowledge is, as it were, between possessing representations and simply having some skill or ability. However, it is also “more than enough,” since the notion of procedural knowledge is sometimes put together with the requirement for the subject to have justifications or warrants for their perceptual beliefs – as has often been the case within the philosophical discipline known as epistemology.[10] Some epistemologists claim even more, namely, that the ascription of knowledge – descriptive or procedural – about a given area to someone always imposes on such a person the requirement of having justification or warrant for the beliefs or skills constituting this piece of knowledge. If one knows how to ride a bicycle, then one ought to provide justification for the belief that one is able to ride a bicycle. One is then somehow forced to enumerate actions constituting this skill, or, if one is dexterous enough, to demonstrate the truth of one’s words without having to provide further evidence.

However, if the ascription of procedural knowledge to someone requires a justification or warrant of some kind (either descriptive or demonstrative), then such knowledge cannot be predicated about creatures that do not possess properly developed linguistic competence – that is, about animals or very young children. In the case of the descriptive justification requirement, they would not be able to formulate the required description, and in the case of demonstrative justification they would not be able to understand what they are asked for.

The objection that has just been described may be called, following the British philosopher Susan Hurley, the objection of overintellectualizing perception (Hurley, 2001).[11] As applied in the context of the ecological theory of perception, it would boil down to stressing that the category of procedural knowledge, in spite of its conspicuous advantage over the categories of mental images or propositional knowledge – which is, of course, an advantage from the point of view of someone criticizing representationalism – requires too high cognitive competence to be useful in that account of perception which Gibson has proposed. Adopting it precludes extending the notion of perception to some creatures that are usually uncontroversially taken as possessing the ability of perception.

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[10] This constraint is put forward within the framework of the so-called classical theory of knowledge. Then, in addition to the requirement of having relevant justification or warrant, it is customary to mention two further conditions: the person must hold a belief and this belief must be true.

[11] This term is used by Hurley (2001) to refer in a different context to what is, in principle, the same difficulty – that is, to the problem caused by an undue tendency to join together the categories of perception, knowledge, and justification.

In response to the suggested difficulty, it is worth availing ourselves of Hurley's idea consisting in the abandonment of the supposed necessity of making use of what epistemologists call justification or warrant. Instead of traditionally conceived justification, one can introduce the condition suggesting the necessity for a subject to whom procedural knowledge is ascribed to follow a certain rule or regularity (Hurley, 2001). A person would believe that an object in front of her is red not because she knows the criteria of applying the concept of red – that is, not because she has the relevant linguistic competence – but because she is able to discriminate between this object and non-red objects, and is able to put it among other red objects having different shapes when she is asked to group together similar objects, and the like. By the same token, we all are able to deploy the logical principle *modus ponens*, but only very few of us are able to describe the criteria of its application, or even write it down in formal notation.

There are many pointers, then, that a solution enabling one to rebut the objection of overintellectualizing perception and at the same time providing the ecological theory of perception with a category of representation, which most psychologists and philosophers regard as indispensable today, is an attempt to combine the notion of procedural knowledge with the conception of cognitive simulation mechanisms. In other words, the ecological theory of perception needs a simulation model of perception. It then becomes a theory advanced in the spirit of moderate, or modest, or simply minimalistic, representationalism.

THE SIMULATION THEORY OF PERCEPTION

What is understood by the simulation conception or theory of perception usually refers either to what is described as "pure" simulation theory or to what is hidden behind the label of emulation theory. In the former case, it is assumed that perceptual doings are realized in virtue of continual arrangements of sensations flowing in through sensory channels, with the remembered map of a perceived area or representation of a single object (Rao *et al*., 2002). Storing particular detailed maps and representations of objects in memory would be unusually costly from the point of view of of the brain as information processing system, but for the so-called filters (Piłat, 2006, p. 68). They result in "filtered" information devoid of elements that are superfluous from the point of view of the perceiving subject's current aim. Thanks to the notion of such a filter, the simulation theory of perception seems to handle various cases very well indeed, including the explanation of the phenomenon of perceptual mistakes. Moreover, failings in precision or simplifications of the perceptual scene gain some cognitive sense within its framework, since they reveal to the perceiver an environment on a certain level of organization, which may happen to be very useful in action (Piłat, 2006, p. 69).

Apparently very promising is the idea of combining the ecological theory of perception with a model evading pictorial and propositional representations, such as the simulation model. And, what is interesting, similarly to Stephen M. Kosslyn's proposal to treat seriously the hypothesis of functional equivalence between perception and imagination, advocates of the simulation approach to perception also draw conclusions from the lesson following from a comparison of visual imagination with motor imagination. The emphasis put on the role of proprioception in forming a perceptual representation of the environment is clearly opposed to pictorial and descriptive conceptions. In the context of the simulation model, the imagination of some movement, for instance raising one's hand, is more akin to "a fictional train of proprioception than to an arrangement based on movements of joints or a sequence of commands to muscles (Piłat, 2006, p. 71).

The simulation theory of perception can make use of the concept of emulator. According to Rick Grush (2004), an emulator may be described as having the following features. First of all, it has a strikingly dual nature. It can both be modally specific – when it is responsible for the occurrence of a particular sensation attributed to the stimulation of the relevant sense – and process information in the amodal or cross-modal manner, that is, not in a sensory-specific way (Grush, 1998). Thanks to amodal processing, an emulator can enable a subject to perceive, for instance, her environment in a perspectival way, while giving the perceiving subject the central place. What is taken into account when all that occurs is not only features associated with the activity of a given sensory channel, activated when registering stimuli flowing in from the environment, but those data that identify the spatial properties of the perceived scene and the location of the perceiving subject in it. Those data are the result of an integration of various partial pieces of information acquired by different senses (Piłat, 2006).

Grush locates an emulator between the control system or module and the executive system or module. In addition, what appears to be the most important and useful for the ecological theory of perception is that he equates an emulator with a copy of the visual matrix – that is, with that on which visual simulation of movements is conducted (Piłat, 2006, p. 71). For instance, simulation of hand movements would be performed with the assistance not of the motor matrix, but of the visual one. Piłat describes the working of an emulator in the following way:

> Grush stipulates the existence on an internal model representing the egocentric environment of the organism. When this model is fed with visual measurements, it produces topographical pictures. The model is continuously fed with information coming from efferent copies of perceptions. An efferent copy, for example “a movement to the right,” changes the state of this model in such a way that the object is now represented more to the left. . . . If . . . this model works without visual measurement, cut off from environmental data, that is off-line, then the result will be a visual image, and if it is confronted with visual data actually flowing in, it serves as an a priori assessment of the layout of objects in the environment of the organism. This assessment will be later revised by sensory residua till the final assessment of the environmental state is obtained (Piłat, 2006, pp. 71-72).

The internal structure or, simply, the architecture of an emulator is described in functional terms:

> The state of the process responsible for receiving a signal coming in from the environment is represented in the theoretical model by the vector *r(t)*. The state of a process is constituted by the causal determination *e(t)* and information noise produced by the process itself, namely *n(t)*. The dynamics of the process itself is represented in the form of a certain matrix *V*, and the measurement of quantity of a signal in the form of a matrix *O*. . . . In this way, not the entire correction is translated into a new state of the system *r(t)*. Information noise is taken into account. . . . In other words, the measurement of an external signal becomes a modifier of the signal in such a way that the interference both of the signal and of the recording of the states of the processes themselves is relatively allowed for (Piłat, 2006, pp. 70-71).

The simulation approach to perceptual information processing is embedded in the wider trend of the so-called dynamic model of mind. Since in the Polish scholarly literature those issues are discussed mainly by Robert Piłat, I shall stick to his account of this approach (see e.g., Piłat, 1999; 2006; 2012).[12]

A DYNAMIC MODEL OF REPRESENTATION

To understand the gist of the dynamic approach to the mind, let us begin with discussing the “behavior” of a certain toy for children known as slinky.

A slinky is an entirely metal or plastic spring that deftly moves on sloping surfaces, and it would not be an overstatement to say that watching the slinky move down the stairs is a real pleasure. The simple construction of the toy has

[12] See also his unpublished essay on Michael Spivey’s work.

enabled it to achieve, in a paradoxical way, a certain grace in its movements, much exceeding the skills of, for instance, the dancing robot Asimo. The movements generated by the spring are not governed by the processing of internal representations of any kind and are not based upon decisions of the executive system. One might say that the "behavior" of the slinky is the result of overloads that are in operation due to gravitational forces and of course its inner-spring physical nature.

The observation of the behavior of this toy for children ought to convince philosophers and psychologists investigating the nature of behavior guided by perceptual information that invoking subject–environment interaction should be recognized as more basic than reference to internal representations of the environment. Many behaviors of a perceiving subject in the environment may be explained not by internal mechanisms of processing representations of that environment, but by passive dynamics, being the effect of the operating gravitational forces, feedback, structure, and so forth (cf. Shapiro, 2011, p. 62).

The outlined intuition can be illustrated in a more scientific way by conclusions drawn from a series of research, conducted by Esther Thelen (Thelen, 1985; Thelen & Smith, 1994), a specialist in developmental psychology. Examining the phenomenon of development of unaided movements in the upright position by babies, she has compared the working of their legs to the movement made by a pair of pendulums (Abrahamsen & Bechtel, 2006, p. 178). The work of pendulums may be described without reference to any kind of internal mechanism supposedly steering it, relying merely on an algorithm that takes into account a temporal variable. One of the most interesting achievements of Thelen and her collaborators is a renewed analysis of the task devised by Jean Piaget in order to establish whether infants have a notion of object permanence (Piaget, 1954). In the version proposed by researchers from Indiana University, infants from seven to twelve months old were shown two cups, and under the cup on the left an attractive object was hidden many times. The infants were able without much difficulty to find the object by looking, as expected, under the cup on the left. After a sequence of identical behaviors, during the second stage of the task the object was moved, to the infants' surprise, and placed under the cup on the right. Yet, the infants were still looking under the cup on the left, although they clearly saw that the object was put under a different cup than previously. Piaget's conclusion from the similar experiment is well known to psychologists today: infants up to the age of two do not possess the notion of permanence, including the concept of object permanence.

Thelen and collaborators believe otherwise. They deploy the notion of the activation field model. According to them, one can formulate, without much difficulty, the relevant equations that will specify the activation of the spatial field, presented as a continuity from the left to the right, with dynamic changes mapped onto the temporal scale. The beginning of the task, when the object was hidden under the cup on the left, brought about the activity of the memory field, whose influence on motor decisions happened to be greater than the influence of the activity of the perception field in the later task. By then, the perception field reached the peak on the right side of the spatial field when the object was hidden under the cup on the right, whereas a higher level of the activity of the memory field conditioned in the initial task influenced the decision to search on the left side of the visual scene. This dominance of the memory field should not be surprising, given that it interweaves with the perception field in all tasks involving motor planning. If the dominance is on the left side of the spatial field, then an infant will reach to the left. What clearly distinguishes Thelen's proposal from Piaget's in the explanation of the results obtained in the experiment concerning object permanence is that the solutions making up its central core are suggested by the dynamic system theory, in which no reference is made to a classically conceived representation of an object.

To sum up, the programmatic antirepresentationalism of the ecological theory of perception may be overcome by introducing into the account of cognitive processes the category of emulation initiated by the senses. The emulation model of perception exemplifies dynamic approaches to cognitive processes.

Finally, it is worthwhile to indicate briefly a certain solution which perhaps will dispel doubts as to whether the ecological theory of perception without the programmatic antirepresentationalism retains its identity.[13] Let us notice that dynamic models of perception have much in common with the ecological theory. The activity of a subject based upon the incessant monitoring of covariability on the level of sensory data and motor data constitutes, as the main argument line of the paper suggests, the gist of the ecological theory of perception. The foundation of the theory should not be seen in the rejection of the category of traditionally conceived representation. It rather seems that, for Gibson, this rejection was a "marketing trick" in order to turn our attention to the fact that undue confidence in the received scientific trends may be harmful. Though antirepresentationalism was a programmatic point of the ecological theory of perception, we should not forget what this program was in its essence. This is perfectly ex-

[13] I am grateful to an anonymous referee for raising this doubt.

pressed by Gibson in the last sentences of his most celebrated book, when he considers the meaning of "invariant" and "constancy": "These terms and concepts are subject to revision as the ecological approach to perception becomes clear. May they never shackle thought as the old terms and concepts have!" (Gibson, 1979/1986, p. 311).[14]

REFERENCES

Abrahamsen, A., & Bechtel, W. (2006). Phenomena and mechanisms: Putting the symbolic, connectionist, and dynamical systems debate in broader perspective. In R. J. Stainton (Ed.), *Contemporary debates in cognitive science* (pp. 159-185). Oxford: Blackwell.

Chemero, A. (2009). *Radical embodied cognitive science*. Cambridge, MA: MIT Press.

Cooper, L. A., & Shepard, R. N. (1973). Chronometric studies of the rotation of mental image. In W. G. Chase (Ed.), *Visual information processing* (pp. 75-176). New York: Academic Press.

Gibson, J. J. (1961/1982). Ecological optics. In W. E. Reed, & R. Jones (Eds.), *Reasons for realism: Selected essays of James J. Gibson* (pp. 61-75). Hillsdale, New Jersey: LEA.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin Company.

Gibson, J. J. (1979/1986). *The ecological approach to visual perception*. Hillsdale, New Jersey: LEA.

Gibson, J. J. (1982). *Reasons for realism: Selected essays of James J. Gibson*. E. Reed & R. Jones (Eds.). Hillsdale, New Jersey: LEA.

Grush, R. (1998). Skill and spatial content. *Electronic Journal of Analytical Philosophy, 6*. Retrieved from http://ejap.louisiana.edu/EJAP/1998/grusharticle98.html

Grush, R. (2004). The emulation theory of representation: Motor control, imagery, and perception. *Behavioral and Brain Sciences, 27*, 377-442.

Hurley, S. (2001). Overintellectualizing the mind. *Philosophy and Phenomenological Research, 63*(2), 423-431.

Klatzky, R. L., MacWhinney, B., & Behrmann, M. (Eds.) (2008). *Embodiment, ego-space, and action*. New York: Psychology Press.

Kosslyn, S. M. (1975). Information representation in visual images. *Cognitive Psychology, 7*, 341-370.

Marmor, G. S., & Zaback, L. A. (1976). Mental rotation by the blind: Does mental rotation depend on visual imagery? *Journal Experimental Psychology, 2*(4), 515-521.

Maruszewski, T. (2001). *Psychologia poznania. Sposoby rozumienia siebie i świata.* Gdańsk: Gdańskie Wydawnictwo Psychologiczne.

Merleau-Ponty, M. (1962). *Phenomenology of perception*. London: Routledge & Kegan Paul.

Nęcka, E., Orzechowski, J., & Szymura, B. (2006). *Psychologia poznawcza*. Warsaw: Wydawnictwo Naukowe PWN.

Noë, A. (2004). *Action in perception*. Cambridge, MA: MIT Press.

Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart and Winston.

[14] I am very grateful to Tadeusz Szubka and Piotr Czyżewski for improving and polishing the English text of the paper.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

Piłat, R. (1999). *Umysł jako model świata*. Warsaw: Wydawnictwo IFiS PAN.

Piłat, R. (2006). *Doświadczenie i pojęcie. Studia z fenomenologii i filozofii umysłu*. Warsaw: Wydawnictwo IFiS PAN.

Piłat, R. (2012). Wyobrażenia, modele umysłowe, pojęcia. In M. Miłkowski, & R. Poczobut (Eds.), *Przewodnik po filozofii umysłu* (pp. 253-310). Cracow: Wydawnictwo WAM.

Piłat, R. (unpublished). *Pojęcie ciągłości umysłu Michaela Spivey'a*. Retrieved from http://marcinmilkowski.pl/downloads/ocena-dynamicznych.pdf.

Rao, P. N., Zelinsky, G. J., Hayhoe, M. M., & Ballard, D. H. (1996). Eye movements in visual cognition: A computational study. In D. S. Touretzky, M. Mozer, & M. Hasselmo (Eds.), pp. 830-836.

Rao, R. P. N., Zelinsky, G. J., Hayhoe, M. M., & Ballard, D. H. (2002). Eye movements in iconic visual search. *Vision Research, 42*, 1447-1463.

Robbins, P., & Aydede, M. (Eds.) (2009). *The Cambridge handbook of situated cognition*. Cambridge: Cambridge University Press.

Schetz, A. (2012). Percepcja bez wrażeń zmysłowych. „Nowa psychologia" J. J. Gibsona. *Roczniki Psychologiczne, 15*(1), 31-53.

Shapiro, L. (2011). *Embodied cognition*. London: Routledge.

Thelen, E. (1985). Developmental origins of motor coordination: Leg movements in human infants. *Developmental Psychobiology, 18*(1), 1-22.

Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action*. Cambridge, MA: MIT Press.

Thompson, E. (2007). *Mind in life: Biology, phenomenology, and the sciences of mind*. Cambridge, MA: Harvard University Press.

Uchnast, Z. (1994). Reinterpretacja założeń psychologii postaci: Od modelu całości jako symbolicznej figury do modelu całości naturalnej jako ekosystemu. *Roczniki Filozoficzne, 42*(4), 33-70.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, MA: MIT Press.

Velmans, M., & Schneider, S. (Eds.) (2007). *The Blackwell companion to conciousness*. Oxford: Blackwell.