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The Theory of Affordances : An Inspiration for Ergonomics

Problemy Profesjologii nr 2, 45-54

2014

Artykuł został opracowany do udostępnienia w internecie przez Muzeum Historii Polski w ramach prac podejmowanych na rzecz zapewnienia otwartego, powszechnego i trwałego dostępu do polskiego dorobku naukowego i kulturalnego. Artykuł jest umieszczony w kolekcji cyfrowej bazhum.muzhp.pl, gromadzącej zawartość polskich czasopism humanistycznych i społecznych.

Tekst jest udostępniony do wykorzystania w ramach dozwolonego użytku.

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THE THEORY OF AFFORDANCES – AN INSPIRATION FOR ERGONOMICS

Abstract

In the paper I am at presenting philosophically reach theory of affordances as a way of extending the range of research methods used in ergonomics. In the paper I am concern with the fundamentals of the theory of affordances as presented originally by Gibson (1977, 1979) and developed by Heft (1989). I highlight philosophically significant aspects of the classical theory of affordances and propose further topics for investigation. I also propose introduction of the notion of rigid affordance for the special class of affordances important for ergonomics.

TEORIA AFORDANCJI – INSPIRACJĄ DLA ERGONOMII

Streszczenie

W artykule prezentuję filozoficznie bogatą, praktycznie płodną, choć nie wolną od kontrowersji, teorię afordancji jako inspirację dla współczesnej ergonomii. W obrębie moich zainteresowań jest pierwotne sformułowanie teorii, takie jakie znaleźć można u Gibsona (1977, 1979) i Hefta (1989). Uwypuklam filozoficznie interesujące aspekty teorii oraz możliwości ich eksploatacji. Ponadto proponuję wprowadzenie pojęcia sztywnej afordancji dla określenia specjalnej klasy afordancji istotnej dla ergonomii.

Introduction

Here is a small philosophical thought experiment. Imagine that you are wandering in mountains. Imagine that, feeling tired, you sit on the rock; do you choose any rock? No, a rock for sitting on must have certain qualities, e.g. its height and width must fall in a certain range, yet one does not have to think for a long time to choose a rock to sit on; in most cases one just sits on an appropriate rock without really considering it. In the city just as in the countryside it does not take long to recognise that the new items in the restaurant can serve as seats (items we call chairs). According to the theory of affordances we simply see what functions an item can serve, what its affordance is – this information is present in the ambient array of light. My aim here is to convince the reader that the theory of affordances in its original formulation offers a fruitful perspective on ergonomics.

Theory of affordances

Gibson was the father of the theory of affordances (1977, 1979); his main idea was to provide an account of meanings and values related directly to a visual experience of the external world. He saw the world and animals' role in the world like cited by him Dewey:

The live animal does not have to project emotions into the objects experienced. Nature is kind and hateful, bland and morose, irritating and comforting, long before she is mathematically qualified or even a congeries of secondary qualities like colours and their shapes. (Dewey 1934:16).

According to Gibson, a theory of perception should recognise that Nature's nature accounts for values and meanings, which are external to the perceiver and are directly 'picked up' from the environment (Gibson 1979:127). According to Gibson the theory of affordances was the medicine for all pains. The term 'affordance' is a neologism for claiming something about both an organism (animal) and the environment it perceives. To paraphrase Gibson (1979:129), affordances are what the environment *affords* the animal, i.e. the possibilities it offers the animal; the kinds of action it makes possible for a given animal at a given time in a given place. Affordances are relational i.e. they emerge from a relationship between an animal – a perceiver – and the environment rather than being exclusively the property of the animal or the environment; however are in one sense grounded in objective, physical reality and dependent on features of the perceiver. This perspective is discussed later in the essay.

'Suitability' is a well-known example of affordance (c.f. Gibson 1979). Consider a physical object that is stable, rigid, flat on the top, sufficiently extended, at knee-height for a given animal (e.g. adult humans); such a surface affords an animal the opportunity to sit, assuming that its rigidity is appropriate to an animal's weight. Features of suitable objects are measurable and describable in physical terms, but to be considered an affordance of suitability for an animal these properties must be specified relative to the animal and are thus not simply abstract physical properties (c.f. Merleau-Ponty 1963). It is also important to note that affordances depend on the size or scale of the animal, an object which provides a good seat – or has good suitability – for a three-year-old will not suit a healthy thirty-year-old and vice versa.

Gibson inferred that a surface with the properties which make it suitable for sitting on should *look* sit-on-able and that if it does, what is perceived visually is the affordance. The surfaces being perceived constitute a seat and thus have a certain value or meaning to the animal. Suitability is just one of many examples of affordance; it seems that the number of examples is infinite, just as the number of affordances in the environment is infinite. Various objects, including living objects like animals and people, offer affordances to other animals and humans. Some objects afford manipulation, communication, nutrition, manufacture etc.; other animals present rich and complex possibilities for interaction such as sexual intercourse,

predation, cooperative behaviour, play, communication etc. Although this article is mostly concerned with affordances of objects rather than other human beings, it is certainly worth noting that humans are incredibly interesting and important sources of affordances for other humans. In the social realm of life humans are greatly concerned about the affordances other people represent: what they invite us to, threaten, do, or simply what the other person is (c.f. Heft 1989, Rączaszek-Leonardi 2013).

According to the Heftian development of the classical theory of affordances (Heft 1989:10) the three important features of affordances are: continuousness (instead of segmentation: we constantly perceive affordances), reciprocity (the environment offers a variety of actions from the one site, an organism chooses the actions which are ‘best’ for it based on its intentional states), cumulativeness (in simple terms the history of interactions with an environment serves as a basis for further development, discovery and perception of affordances and actions).

Ergonomics

The International Ergonomics Association (see IEA website: <http://www.iea.cc/whats/>) gives the following definition of ergonomics:

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance.

The word ergonomics stems from the Greek words *ergon* meaning work and *nomos* meaning laws and thus its direct meaning is ‘the science of work’. An interesting fact is that the term was first used by the Polish researcher Jastrzębowski in an 1857 article “Rys ergonomii czyli nauki o pracy, opartej na prawdach poczerpiętych z Nauki Przyrody” (eng.: *The Outline of Ergonomics; i.e. Science of Work, Based on the Truths Taken from the Natural Sciences*).

According to the International Ergonomics Association (see IEA website: <http://www.iea.cc/whats/>), ergonomics can be categorised into four specialisms:

Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. (Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health.)

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor responses, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.)

Organisational ergonomics is concerned with the optimisation of sociotechnical systems, including their organisational structures, policies, and processes. (Relevant topics

(include communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, virtual organisations, telework, and quality management.)

In broad terms ergonomics is the study of the influence of environment (in the widest sense, albeit first and foremost the human-enhanced environment) on people in typical, though constantly changing in our times, work situation. Ergonomics focuses on enhancing human performance and well-being by optimising the environmental features (in a very broad sense) humans interact with. In this context it should be recognised how the analysis of working environment, working techniques, working spaces, workload, work stress, human-computer interaction, telework, new work paradigms, cooperative work, as well as working postures and many others can be analysed in terms of affordances, and how such a handling can make the work of ergonomics professionals more effective.

Ecological theory of perception

It is obvious that in this framework perception is a process of direct inspection, not representation (c.f. Noe and Thompson 2002: 4-5). Let us allow Gibson (1974: 239-240) to speak for himself:

Perceiving is an achievement of the individual, not an appearance in the theatre of consciousness. It is a keeping-in-touch with the world, an experience of things rather than having of experiences. It involves awareness-of instead of just awareness. It may be awareness of something in the environment or something in the observer or both at once, but there is no content of awareness independent of that which one is aware... perception is not a mental act. Neither is it a bodily act. Perceiving is a psychosomatic act, not of mind or of body but of a living observer.

To Gibson perception was not merely the reception of physical energy by the retina, followed by further physical processes. Gibson saw perception as the ‘picking up’ of invariant information from the ambient array of light (c.f. Heft 1989), for example one can perceive the very special pattern at the edge of the precipice:

The slightest movement results in a shearing of the texture of the ground on the surface below by the edge of the surface of support. (Gibson 1979)

This transformation in the reflected light generated by an observer moving relative to this arrangement of surfaces conveys the information that there is a break in the supporting surface; in other words it means ‘here is a falling-off place’. This meaning is carried in the structure of reflected light. It is a perceivable fact, not a mental construction imposed on sensory input. It is important to this account of perception that the perceiver is active in the environment, moving a lot in all possible directions, using his or her body actively as a tool for perception.

It seems to me that the ecological theory of perception is exactly what stands behind the ergonomics. The working area should be designed in such a way that it is sensitive to workers movements. It should allow and facilitate exercising certain tasks with respect to possible changes in body posture on the one hand, and should facilitate taking the comfortable body posture on the other. And since perception is important in every working tasks and crucially important in some (like in driving or flight control) the concept of perception as *a psychosomatic act* (as in Gibson 1977: 239-240) should gain the special importance – since it shows how poor is the distinction of sub domains of ergonomics provided by International Ergonomics Association (IEA website: <http://www.iea.cc/whats/> and cited above). It appears that working human should be regarded holistically, as the perceiver and agent.

Environment

Gibson's perspective on the environment is worth mentioning in passing. First of all, environment is everything that surrounds animals, specifically humans; the world, the Earth is our environment. Gibson asserted that we do not live in some kind of new, artificial environment, for example a city, which can be contrasted with the natural, untouched Amazon jungle. Gibson argued that there is only one diverse environment. Humans, by altering the Earth, have extended its positive affordances for themselves and reduced the number of negative affordances whilst very often achieving completely for the opposite for other species (Gibson 1977:130).

For ergonomics similarly, environment is every surroundings that appears in any work-related context. Specifically, it could be an industrial office, a cosy home couch or even Amazon jungle. And similarly to Gibson's account, for ergonomics it is only important how a given part of a diverse environment can be enhanced to suit better workers needs. So, in other words, what is the interest of ergonomics is not surroundings itself, but what affordances it is capable of providing for the worker, both: naturally and by enhancement with human hand.

Situatedness and the body

It is obvious from the description of affordances above that scale plays a crucial role. This role goes even further if we assume that the body is an important means of expressing animals' intentions, as Merleau-Ponty's (1963) suggested:

The body is the vehicle for being in the world, and having a body is, for a living creature, to be involved in a definite environment, to identify oneself with certain projects and be continually committed to them.

Even one committed to the analytical way of thinking cannot help admitting that there is something compelling in Merleau-Ponty's words; projects are to be understood simply as the goal-directed, intentional (in the simplest and most 'psychological' sense of the word) actions undertaken by an animal. Surely we pursue multiple projects on multiple time-scales every second of our waking life. The body plays a crucial role here; it is more than a physiological organ, it is a way of being in the world. This leads us to the notion of *situatedness*, which states that our bodies and all our actions are situated in a world and that no action – or more importantly intention – can be described without reference to an organism's situation in the world. In this sense intentions are not mental representations; they are possibilities that are only realisable in the context of situated behaviour (Heft 1989:11). An individual's body and its physical characteristics (including psychological characteristics), together with its relationship to the environmental setting and overall situation (including history) constrains the range of actions open to the individual at any particular time and in any particular place. As Heft concludes, an affordance should be seen in relation to an organism's intentional acts; every feature of the environment that is implicated in intentional, goal-directed action, can be attributed of the meaning.

The earth is full of objects that have multiple affordances because of their shape and other physical characteristics (weight, transparency etc.). According to Gibson what we perceive when we look at objects are their affordances not, as some would have it, their qualities. Gibson (1979:132) drew readers' attention to the fact that although people are able to discriminate certain properties in artificial experimental settings the combinations of qualities that could be discriminated in such situations are not what we normally pay attention to when looking at objects. Ecological psychology claims that in everyday life we do not notice the qualities of an object, simply its affordances. According to the theory of affordances to perceive an object is not to classify it. An object can have multiple affordances; Gibson (1977:138) stated that:

These affordances are all consistent with one another. The differences between them are not clear-cut, and the arbitrary names by which they are called do not count for perception.

To summarise: no matter what one calls an object, the most important thing is that one knows what to do with it. The clue to the importance of affordances is that if you know what can be done with an object you can call it whatever you like (c.f. Heft 1989: 14). Developmental psychology has provided confirmation for affordances as well. Infants do not begin to see objects of the world in terms of their abstract qualities; their perception of the world is based on the opportunities it affords them, what it means for them (c.f. Rączaszek-Leonardi 2013).

Ergonomics, implicitly, acknowledges situatedness. Working life is focused around certain goal-directed, intentional actions – "projects". And also, very often it is not important what the tools are called, but it is inevitable to know how to use them – quickly and without

hesitation, with minimal risk of error. Sub domain that fully acknowledges the aforementioned features is Physical ergonomics (International Ergonomics Association, compare above).

Behaviour

Affordances are the environmental counterparts of an animal's behavioural potentialities (Gibson 1977, 1979). Heft (1989:10) stated that the relationship between an affordance and behaviour corresponds to that between fittedness and compatibility. This is not to say that affordance is the simple behavioural response or that it prompts the simple behavioural response; it is rather that affordance constrains the repertoire of actions available to an animal and/or creates new potential actions. The perceived world is conceived as a set of affordances, i.e. the resources provided by the environment for an animal; if the animal is continuously active in the environment these resources become opportunities for action. These possibilities can be exploited, for example a human can sit on a chair, mug a weaker robber who made him or her angry, use a hammer to hammer a nail, eat a cake; alternatively one may see the possibility for action and resist it, for example not taking a seat in a crowded bus to allow an elderly person to sit instead, capture the robber without mugging, not the hammer a nail, or eat a banana instead of a cake. In declining one action one typically makes use of the other affordances present in the environment, sometimes referring to very complicated, socially learned concepts and rules, for example the concept of a judicial system in civilised society or normative ideas about what constitutes a healthy lifestyle or diet. As Heft asserted the way in which affordances of objects are vividly present to us and the actions we choose depend on our animal intentional mental states, i.e. desires and needs. It is not a mystery (at least for sales managers) that in a grocery a hungry human acts differently from a sated one, especially if there is a smell of fresh bread smell (c.f. Tal and Wansink 2013). A book will present different affordances according to whether the perceiver seeks to learn, prop a window open or is cold and needs to light a fire.

However I fully acknowledge the intentional analysis of affordance as proposed by Heft, I am also prompt to think that in certain working and living environment we need affordances that would be in a sense stronger and less sensitive to our intentions. However, I am still far from embracing sheer behaviourism. In my opinion, the intentional analysis of affordances is important for ergonomics; an intentional analysis of affordances relates the affordances one sees in the object to one's or organizational's goals and needs. In some contexts however it appears to be desirable for an object to have affordances that in any case would result in the demanded action; that despite the broader circumstances the specific action would be elicited. In certain contexts there is a need for *rigid affordances* which

compel individuals to act in a specific certain way, i.e. they elicit a specific behaviour simply by virtue of their presence. For example, we want pedestrians to cross the road at zebra crossings rather than at any point and we want students to sit still at their desks etc.; these are all apparently things which can be achieved by designing the environment appropriately so that the first perceived affordance of the environment is the desired one. Of course, rigid affordances can be without contradiction culturally (or broader: contextually – for example in working context) learned.

Valence

I have assumed that the term ‘valence’ refers to value, meaning and affective direction. As Gibson (1969:134) stated:

Note that all these benefits and injuries, these safeties and dangers, these positive and negative affordances are properties of things taken with reference to an observer but not properties of the experience of the observer. They are not subjective values; they are not feelings of pleasure or pain added to neutral perceptions. (...) There is only one environment, although it contains many observers with limitless opportunities for them to live in it.

The theory of affordances is a theory of perception in which the environment is conceived as being rich in meaning and value. According to the theory of affordances every surface, object or other animal is a source of affordance, and thus everything has value, valence and meaning. Gibson (1969:128) explained the concept of affordances thus:

But, actually, an 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 behaviour. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer.

As we saw above, affordances are relative, i.e. neither subjective nor objective but intersubjective; Heft (after Gibson’s original position) also made a significant effort to prove that, in one sense, despite their relational character affordances exist independently of the perceiver. Heft used two main arguments, first that affordances *can be viewed as dispositional properties of environmental features taken at a behavioural level of analysis* (Heft 1989:24). This should assure the affordance possibility to be describable in terms of physics. Second, Heft (1989:24) reminded us that an affordance, as perceived in the ambient array of light is *always there to be perceived*, and therefore does not exist only in the eye of the beholder; it is somewhere in the environment waiting for that eye. Heft sees affordances as existing in relational domain and within this domain affordances existed independently of the perceiver, as potential properties of the environment (Heft 1989:25). As an animal does not simply exist

passively in its environment some affordances will be realised in the animal's actions. It is also worth noting that from an ecological standpoint, possibilities or dispositional properties (c.f. Turvey, Shaw, Reed, and Mace 1981) are the real, ontological category of being; in other words a substance does not have to exhibit the relevant property for an affordance related to it to be perceived, for example one does not have to see sugar dissolving in water to perceive its affordance as a solute nor does one have to be killed with potassium cyanide to perceive its affordance as a threat to life.

Since the one main aim of ergonomics as the practical discipline is to enhance people's well-being in working spaces it is obvious that it, at least implicitly, cares for meanings and values present in the environment. In that respect, it seems, analysis of working spaces in terms of affordances could bring great benefit for the field of ergonomics.

Affordances in ergonomics – concluding word

From an ergonomics perspective, affordances and affordance analysis of working spaces is crucial as the concept of affordances seems to capture what is important for the successful design of a working area. The term 'ergonomics' encompasses all features of human experience, including emotions and evaluations and is definitely one that is meant to serve for practice and in that respect some theoretical problems with the notions can be neglected. The same with affordance – it seems that the vagueness of the concept of affordance and the lack of a stable definition of the term is not a problem for ergonomics, since it is interested rather in the practical operationalization of the concept; nonetheless one should be wary of overusing the concept.

We have already noted that other people can serve as affordances. It is worth considering whether being able to elicit certain affordances should be the primary feature of every professional working with people. When the social realm of interactions is considered as a part of the bigger, dynamic organisational system, it is inevitable to see how psychological and sociotechnical factors are shaping the working environment.

In conclusion, the theory of affordances provides both theoretical and practical insights that can be used in ergonomics. The perspective of the theory of affordances, should definitely be embraced in Polish investigations and taken into consideration by Polish researchers. In brief, from an ergonomic perspective the most important features of affordances lie in their connections to the ecological theory of perception; the theory of affordances states that perceiving is an active process in which the animal or human moves and actively inspects the environment and is thus able to perceive meanings and values directly in the environment. These meanings and values can be used in ergonomics; enhancements of the environment should be like affordances – directly perceivable – and one

should remember that perception is never value-free perception. In summary, I think that the concept of affordances is rich enough to serve as a tool for analysing environments and appliances in ergonomic studies.

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