The Cognition-Perception Distinction Across Paradigms: An Ecological View

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Abstract

Folk psychology takes perception and cognition to be two distinct processes. It seems that when we perceive the world we are engaged in one kind of activity and when we think about it we are engaged in a different one. This conception underlies various discussions within the cognitive sciences, such as on the architecture and modularity of the mind, and the cognitive penetrability of perception. But is the distinction justified? This paper looks for an answer in two opposing paradigms in the sciences of the mind: traditional cognitivism and ecological psychology. Even though cognitivism is the dominant paradigm, we argue that it has thus far failed to give a definite account of the relation between perception and cognition, and to support or to deny their separation. Ecological psychology, on the other hand, rejects the distinction and integrates cognition with perception. We discuss previous work within the ecological view and sketch directions for future research.

Keywords: cognition; perception; folk psychology; cognitivism; ecological psychology

Introduction

As you read these words, you are looking at something, be it the screen of your computer, tablet, or other electronic device, or perhaps the paper you used to print out this text. In addition to seeing the screen or paper, you may also see other objects around you, such as a table, a mug, a chair, a wall, etc. Seeing each of these things is an instance of *perception*. As you keep reading, if you get distracted, you may find yourself wondering if you locked your front door this morning, or you will start rehearsing an important email you plan to send later, or maybe you will try to remember what groceries you need to buy for dinner. These are instances of *cognition*. Part of the process of reading this text might seem to fall in the latter category as well: reading involves recognizing certain symbols and understanding what they mean in combination, which appears to be different from merely staring at the screen or paper.

These examples from daily life point to a folk psychological separation between perception and cognition. We take them to be two different mental activities: when we perceive something, we do one kind of thing; when we think, we do something different. Such a separation goes beyond our ordinary experiences and can be persistently found in the history of philosophy and the sciences of the mind. For example, Plato distinguished between the world of appearances, gathered by the senses, and the world of Ideas, contemplated only through reason. The Cartesian skeptical methodology is also based on the distinction between perception and cognition: the senses can deceive us, but if we reach certain truth through reason, we are in the right path to knowledge. And Kantian transcendental idealism, with its depiction of knowledge as a synthesis between intuition and understanding, rests on the same distinction.

An overarching task of philosophical and scientific inquiry is to evaluate our folk conceptions and, when necessary, to correct them. In the case of this widely accepted distinction between perception and cognition, the task is to determine what (if anything) distinguishes the two and how they relate to one another. For example, the idea that perception and cognition are distinct could turn out to be right, and if so, an important task would be to elucidate whether the two interact and how (e.g., is there unidirectional influence, or is it bidirectional?). If, however, the distinction turns out to be wrong, a key task would be to explain the unity of what appeared to be two different things, and to do this in a way that does justice to the relative success of the distinction in everyday contexts.

In light of the task above, our goal in this paper is to determine how different paradigms in cognitive science fare in relation to the perception-cognition distinction—i.e., to determine if different theories mean to support or correct such a distinction, and how successfully they do that. To this end, we will contrast cognitivism, the dominant approach in cognitive science, with the ecological approach to psychology developed by J. J. Gibson. Cognitivism appears to take for granted the intuitive distinction between perception and cognition. Yet, we argue that recent developments reveal the framework to be inconclusive on this topic (section 2). Ecological psychology, on the other hand, is often interpreted as precluding talk of anything mental, which would seem to entail a rejection of the perception-cognition distinction on the grounds that cognition does not exist. We agree that the ecological view goes against the distinction, but we argue that it does so in a different way, namely by re-describing cognition as an extension of perception. We review the main tenets of ecological psychology (section 3) and we conclude by sketching how an ecological account of cognition can make sense of everyday psychological experience (section 4).

Cognitivism: An Inconclusive Paradigm

Cognitivism is both the foundational and the dominant paradigm of the cognitive sciences (Miller 2003, Thagard 2005, Clark 2014/2001). It offers a depiction of cognitive systems as having three main features: modularity, computation, and representationalism. First, *modularity* stands for the compartmentalization of cognitive functions in different elements of the cognitive systems (Fodor 1983). Put simply, each cognitive function (e.g., visual perception, auditory perception, memory, decision making, etc.) is implemented in and realized by a specific module of the system. Some instantiations of modularity are, for example, the cognitive architectures based on the ACT-R models (Anderson 2007). These models consist of a group of, at least, seven interconnected modules each one accounting for the realization of one cognitive function. So, in ACT-R models, there is a visual module, for example, that carries out the processes for visual perception. The same applies for auditory perception, imagination, decision making, and so on.

The second fundamental feature of cognitive systems according to the main tenets of cognitivism is *computation*. Cognitive systems are a kind of computer and, thus, their processes may be explained in terms of rules or algorithms that are somehow instantiated in the system and that are applied to the input arriving to it—for example, a kind of input might be sensory stimulation. In this sense, every module of a given cognitive system is realizing a computational function, and such a computational function is the cognitive function. In the case of perception, the cognitive function is the building up of a representation of the outer world. This is *representationalism*, the third fundamental feature of cognitive systems according to cognitivism. Representations are the objects of perception, and perception as a cognitive function is defined in terms of their construction.[1]

Given this big-picture description of cognitive functions in terms of cognitivism, the answers to the driving questions of this paper seem to lead to a paradoxical conclusion. On the one hand, and because of modularity, it seems that cognitivism confirms the separation of perception and cognition. Perception and high-order cognitive functions are realized by different modules and, in this sense, they are separated functions. On the other hand, however, perception is a cognitive function in itself as far as it is the building up of representations of the outer world by means of processing stimulation using some internal rules, etc. In other words, perception is a form of cognition as well, and conceiving them as separate seems to be wrong after all.

The paradoxical relation between perception and cognition within cognitivism becomes explicit, for example, in Pylyshyn's work on cognitive penetrability (1999). In this work, he claims that perception is based on some cognitive resources but, at the same time, he claims that perception is not cognitively penetrable:

> The early vision system carries out complex computations (...) Many of these computations involve what is called *top-down processing* (...) What this means is that the *interpretation* of parts of a stimulus may depend on the joint (or even prior) interpretation of other parts of the stimulus (...) The *early vision system is encapsulated from cognition*, or to use the terms we prefer, it is cognitively impenetrable. (Pylyshyn 1999: 343-344; emphasis is ours).

It seems, given this quote, that there are two meanings of 'cognitive' at play. On the one hand, there is a top-down interpretation of the stimulus. We think that the only sensible way to understand this claim is that early vision is based on some cognitive resources and, therefore, is a cognitive function. On the other hand, early vision is not cognitively penetrable, so there must be a distinction between early vision and cognition, and the latter is unable to interact with the former. In his sense, early vision is not cognitive as far as it is not part of this other kind of cognition.

One of the consequences of this paradox is that it makes the distinction between perception and cognition appear to be arbitrary. Although perception is a cognitive function, what cognitivists call 'cognition' is the set of high-order cognitive functions defined in opposition to perception; namely, cognition is the set of cognitive functions that are not the cognitive function of perception. But accepting this arbitrary distinction only leads to more confusion. Within cognitivism, for example, some accounts place a distinction within high-order cognition that makes some forms of allegedly high-order cognitive functions very similar to perception, so they might be non-cognitive in the same sense the latter is (e.g., System 1-System 2 theories; see Kahneman 2011). In the same flavor, other authors, trying to reject the possibility of cognitive penetrability or top-down effects in perception, account for many effects traditionally understood as instances of high-order cognition, as merely perceptual effects (see Firestone and Scholl 2016). In both cases, the two ways of being 'cognitive' that cognitivism seems to suggest are arbitrarily—and differentially—delimited.

Summing up, it seems that perception is both cognitive and non-cognitive within cognitivism. This situation entails that it is not clear what counts as perception and what counts as cognition. Thus, the driving question of this paper seems very difficult to be answered given the main tenets of the paradigm: if the distinction between perception and cognition is not clear, we cannot know whether they are separated or not, or what kind of relation they hold. This lack of clarity in cognitivism further motivates paying attention to what a

[1] Of course, the process of building up a representation is complex and there are different ways to understand it within cognitivism, from classic computational models based on the application of explicit language-like rules to discrete sensations (Fodor 1975) to network models where representations are constructed by a hierarchical bidirectional processing of the sensory input following, for example, the free-energy principle (Friston 2010). However, the differences between these accounts are not essential for the aims of this paper.

different paradigm can tell us about perception and cognition, their status and their relation. We turn to this now.

Ecological Psychology: A Challenge to Folk Psychology

In contrast with cognitivism, the Gibsonian ecological approach to perception locates psychological phenomena at the ecological scale, naturally shifting the focus away from psychological explanations based on internal mechanisms toward psychological explanations based on animal-environment dynamics (Raja et al. 2017). This shift has been misinterpreted by many as an attempt to exclude "mental" phenomena from psychological science, and a form of behaviorism. Bunge and Ardila (2012), for instance, mention ecological psychology in their discussion of behaviorism, stating that the two accept the thesis that "animal behavior is exclusively determined by environmental circumstances"; they further add: "Both hold that behavior is the sole effect of environmental stimuli; both model the organism as an empty box. The difference between them is that, whereas ecological psychology focuses on perception, behaviorism is mainly interested in overt behavior" (Bunge and Ardila 2012: 120). Others have drawn similar comparison between ecological psychology and behaviorism, both approvingly (e.g., Barrett 2016) and disapprovingly (e.g., Fodor and Pylyshyn 1981, Shapiro 2010).

Claims like these suggest that ecological psychology rejects the cognition-perception distinction by outright denying the existence of "higher" cognitive abilities. But we argue that this is not correct. Gibson himself proposed that the ecological approach to perception calls for a corresponding ecological account of cognition: "The ecological theory of direct perception cannot stand by itself. It implies a new theory of cognition in general" (Gibson 1979/1986: 263), and "the redefinition of perception implies a redefinition of the so-called higher mental processes" (p. 255). Our goal, then, will be to identify what the ecological framework entails for the distinction under examination. We will argue that it undermines the separation between perception and cognition, but that it does so by integrating cognition into perception rather than denying its existence. Before that, however, it will be important to review the main tenets of ecological psychology.

A Primer on Ecological Psychology

The central ideas in Gibson's theory of perception are that perception is direct, active, and action oriented (1966, 1979). First, saying that perception is *direct* means that perception is not mediated by mental representations. The traditional cognitivist view holds that perception is the construction of mental representations out of sensory stimulation through some kind of computational process (Marr 1980, Fodor 1987). Gibson rejects the idea that perception is mediated by representations: instead, he proposes that we have direct, unmediated perceptual access to our surroundings. To perceive is a matter of *detecting* the relevant environmental information to control behavior in a specific action. In this sense, perception is *active* and *for action*.

When ecological psychologists claim that perception is *active*, they mean perception is something organisms do. Therefore, perception cannot be equated to passive sensory stimulation. For example, traditional approaches attempt to explain visual perception by studying the retina as a photoreceptor. However, Gibson (1979/1986) explains, a receptor is "passive, elementary, anatomical" and gets "stimulated" whenever it is touched by the right type of energy, such as light in the case of the eye (p. 53). Yet perception is not merely the passive excitation of our sensory receptors or external stimuli impinging upon our sense organs: "the eye is part of a dual organ, one of a pair of mobile eyes, and they are set in a head that can turn, attached to a body that can move from place to place" and together, all of these elements make up our (visual) perceptual system (p. 53). In the ecological view, we cannot understand perception merely by understanding how sensory receptors work because perception is the *activity* of a coordinated system that is only partly composed by the receptors: "perceiving is an act, not a response, an act of attention, not a triggered impression, an achievement, not a reflex" (p. 149).

As perception is direct and active, it is also *action oriented* and works in service of action. This amounts to a special claim about the objects of perception. According to Gibson, perception is of higher-order relational properties he refers to as 'affordances'. When we see an object, we do not first perceive discrete primary qualities that we then need to combine in order to decide what we can do with that object. Instead, in the process of actively exploring our environment, we directly perceive the possibilities for action afforded by those objects. 'Affordances', as Gibson used the term, are agent-relative properties, or the "properties of things taken with reference to an observer" (Gibson 1979/1986: 137); they have also been described as "relations between the abilities of organisms and features of the environment" (Chemero 2003: 189). The environment affords various kinds of action: some surfaces afford walking over, sitting on or leaning against, and some tools afford grasping, throwing, cutting with, or writing with. But these action possibilities are all possible *for* someone with specific abilities, and it is in this sense that they are relational or agent-relative properties. Air affords breathing, and water affords drinking and swimming as well as drowning—but these properties exist only in relation to terrestrial animals, and not for fish, who can breath underwater but do not survive outside it. In Gibson's view, then, perception is action oriented in that the objects of perception are agent-relative properties: in perception we directly and actively perceive the affordances our environment provides us.

The main consequence of these features is that, given a specific action, perception is *the picking up of relevant ecological information*. On the notion of ecological information, Gibson (1979/1986) says: "information about a world that surrounds a point of observation implies information about the point of observation that is surrounded by a world. Each kind of information implies the other." (p. 75). And, because perception is based on ecological information, "self-perception and environment perception go hand in hand." (p. 116). This means that the same perceptual event in which we perceive our surroundings is necessarily also an instance of perceiving ourselves and how we relate to that environment: perception tells us about our own situation and our own action. Ecological information is rich enough to be informative about all these aspects of our interaction with the environment. But, is it rich enough that cognitive scientists can use it to explain events usually regarded as involving cognition? We explore the answer to this question in the next section.

Cognition from an Ecological Perspective

A common interpretation of Gibson's ideas is that ecological psychology precludes talk of anything 'mental' or 'cognitive'. And, in fact, the ecological theory *of perception*, as seen in the previous section, does not make reference to any kind of cognitive processing. Moreover, ecological psychology clearly rejects the idea that perception is 'cognitive' in the sense of involving the building up of mental representations. Yet, this does not mean that ecological psychology has to deny the existence of, nor remain silent about, the psychological phenomena we ordinarily call imagining, remembering, learning, planning, problem solving, etc. According to Gibson there is continuity between perception and these sorts of events. He claims that "to perceive the environment and to conceive it are different in degree but not in kind. One is continuous with the other," and he adds that "knowing is an extension of perceiving" (Gibson 1979/1986: 258). Our goal will be to shed light on these claims made by Gibson and to identify resources that can be used in an account of cognition that is compatible with the principles of ecological psychology. This can provide guidance for future scientific work as well as a more conclusive basis for correcting our folk conceptions about how perception and cognition relate to one another.

Cognitive Extensions of Perception

What does it mean to say that knowing is an extension of perceiving? And, more generally, what does it mean to say that there is continuity between perception, on the one hand, and cognition, on the other? Before we examine answers to these questions, it is helpful to consider what a *non-cognitive* extension of perception would be. A good example is when we use binoculars, microscopes, or telescopes. These instruments extend perception by allowing us to see things that are too far away or too small to see with the naked eye. This is a legitimate extension of perception, but it does not amount to the "high" cognitive phenomena we are interested in. Instead, we will focus on three senses of "extended perception" which help to explain high cognitive functions in perceptual terms and in continuity with perception.

The first sense of "extended perception" has to do with the richness and pervasiveness of ecological information during perceptual events and its relevance for the distinction between past, present, and future events. One example of this fact can be found in anticipatory behavior. Cognitive systems are able to organize their own behavior toward a *future* state of affairs relying solely on the present state of affairs as input. For example, an outfielder is able to catch a fly ball by predicting its landing location just by seeing the ball in the present moment. Such a skill is known as *anticipation* (Dubios 2003). Anticipation has been classically explained in terms of an internal model of the environment:

> If the organism carries a ''small scale model" of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize knowledge of past events in dealing with the present and future, and in every way react in a much fuller, safer, and more competent manner to the emergencies which face it. (Craik 1943: 61)

In this case, the organism aims towards a future state of affairs that is explicitly predicted by a cognitive process. However, scholars working within the ecological approach have argued that anticipation may be explained by the online, embodied interaction of the organism with its environment, with which the future state of affairs is only implicitly related (Stepp and Turvey 2009). As Keijzer (2001) states it, "perhaps behavior is not anticipatory at all, but a result from immediate organism-environment couplings." (p. 192). In the case of an outfielder trying to catch a fly ball, she uses information that specifies the landing position of the fly ball through a process of online organism-environment interaction (see studies by Todd 1981, or Fink et al. 2009). In other words, a skill like anticipation, supposedly enabled by cognition as far as it involves events that are not available online, is just an extension (a direct consequence) of an online process of perception.

In a similar vein, the first sense of "extended perception" can be also found by recognizing the spatiotemporal persistency of perceptual information and perceptual events. One example relates to memory and expectation (which is a form of anticipation as well). As William Mace (1986) emphasizes, the momentary absence of the object remembered or expected does not entail the absence of information pickup (i.e., perception): information is not instantaneous or static; it lasts in time and it also changes over time. We have seen that information about what surrounds a point of observation is also information about the point of observation itself. Similarly, ecological *change* provides information about what came before and what comes after that change as well—or, more precisely, the *direction* of change specifies both what the change is toward and away from. Consider: if you turn away from the computer that is in front of you so that you can no longer see it, you will still know that you just need to turn back toward it in order to see it again. What explains this? Do you "remember" where the computer was and therefore "predict" you will see it again when you turn back? Instead of positing memory and expectation in representational terms, a more parsimonious explanation is that the orderly process by which the computer was occluded (i.e., your turning away in one direction) also specifies how it can be brought back to sight (i.e., by performing the inverse movement). This is why Mace claims: "Orderly optical consequences of a change can constitute information—even if it occurs over time, even if it continues to occur for a very long time" (p. 153). As Mace suggests, the boundaries between present, past and future are not clearly defined at the ecological scale, and thus cannot determine what separates memory and expectation from perception. Accordingly, many ordinary instances of "remembering" or "anticipating" are continuous with perception insofar as they, too, are instances of picking up ecological information (and informational change) over time.

Along similar lines, van Dijk and Withagen (2016) dissolve the distinction between "online" and "offline" cognition. Information and perception are not instantaneous and punctate, but this is not because they are sui generis. Rather, it is a basic fact of ecology that events occur over multiple spatiotemporal scales, and the same applies to psychological phenomena understood from an ecological perspective. As van Dijk and Withagen argue, the intuition that we inhabit the abstract time of physics (Newtonian time) rather than the nested space-time of ecology makes it hard to explain how we perceive complex structures like houses and cities. If perception is "locked in the present," then anything not currently visible (i.e., not available for "online" processing) is only accessible if it has been internally represented (i.e., prepared for "offline" cognition). But, they suggest, we only need to posit persistent internal structures (i.e., representations) if we choose to ignore the persistency of ecological structure. Navigating complex environments and understanding them in their entirety does not require the construction of a mental map: "By continuously exploring, even large scale structures, such as houses or towns, can be apprehended"; and "through ongoing activity an agent becomes sensitive to the motions of optical structure, to information, at any scale" (van Dijk and Withagen 2016: 10). The perception of affordances in particular vistas (hallways and doors in a house, streets and landmarks in a city) thus "become nested into larger structures that are themselves then also perceivable" (p. 10). Information and information pick up thus extend back and forward beyond the present time because they exist at the ecological scale. Accordingly, many instances of "high cognition" need not be explained in terms of internal representational structure: "on- and offline cognition are not different types of cognition but only different modes of coordinated motion" (p. 7).

The insights articulated in the ecological literature on anticipatory behavior, along with the ones suggested by Mace and by van Dijk and Withagen, support what we refer to as a first sense of cognition as extended perception. This first sense frames the continuity between perception and cognition in terms of the spatiotemporal extension of perceptual information and perceptual events. However, additional senses of extended perception have not received adequate attention in the literature. Here we briefly discuss two of them.

Cognitive abilities can arise as extensions of perception through *action*. As we have seen in section 3, perception is *active* and *for* action. But the important point here is that action can provide cognitive extensions of perception in two ways, either through the performance of novel actions in the same environment or through the repetition of the same action. On the one hand, carrying out novel actions allows us to fine-tune perception. By changing our actions, we generate new exploratory patterns of the environment. For example, by changing the position of our head, or by jumping, we can gain access to new ecological information. This allows us to discover new informational variables more optimal to accomplishing the task at hand. On the other hand, through the repetition of the same action, and by adjusting the specific action patterns, we also get to pick up more optimal information to achieve specific behavioral goals. This is how, for instance, beginners become experts through practice (e.g., becoming an expert wine taster). In other words, either by changing our actions or by adjusting the same action patterns, we can fine-tune perception. This fine-tuning of perception accounts for learning (Jacobs and Michaels 2007). Many instances of what we ordinarily understand as memory and problem solving, for example, fall under the same umbrella and can be understood as continuous with perception, and as cognitive extensions of perception.

The last and least understood cognitive extension of perception occurs when information becomes fully detached from stimulation and the organism can behave based on that information without stimulation. Consider the following quote by Gibson:

> a perceptual system that has become sensitized to certain invariants and can extract them from the stimulus flux can also operate without the constraints of the stimulus flux. Information becomes further detached from stimulation. The adjustment loops for looking around, looking at, scanning, and focusing are then inoperative. The visual system visualizes. But this is still an activity of the system, not an appearance in the theater of consciousness. (Gibson 1979/1986: 256).

This might be the most extreme case of a cognitive extension of perception. This is because, in principle, information is not available in the same way it is available when the stimulus flux is present. However, ecological psychology provides the resources to understand how, even in the absence of some particular information to be picked up from the stimulus flux, we can talk about an event of extended perception. There are situations in which the agent, after having interacted with her environment during some time can perform actions *as if* the information were available. Suppose you are in a room you already know well, i.e., you are familiar with the perceptual information available in the room. In this case, you will probably be able to navigate the room quite successfully even in the dark or with your eyes closed. This is possible, first, because even when some particular visual information is not available in the stimulus flux, you still have some other information available such as proprioception of different sorts: equilibrium, position of the limbs, and so on. And second, this is possible because, through previous interactions with that specific environment, you have mastered some patterns of action that you can exhibit even in the absence of their related information. In this sense, your action may be organized as if the environmental information were there and without the need for its appearance in your theater of consciousness. With enough practice, the visual system can visualize, and you are able to navigate a well-known room with your eyes closed by relying on other information available and on action patterns you have mastered. Much the same happens when you rehearse navigating a room that you are not currently in. Just as the visual system can become capable of visualizing a room as you navigate it in the dark based on non-visual information and your action patterns, practice and experience also enables the visual system to visualize navigating the room even when you are not in fact navigating it but only "imagining" it.

Conclusion

The three ways of extending perception we have articulated provide the conceptual framework ecological psychology needs for its *scaling up*. These are resources ecological psychology already has at its disposal and can apply to develop a full understanding of cognition. By identifying these resources as revealing cognitive extensions of perception, our hope is first to make clear *why* the ecological approach rejects the cognitive-perception distinction: not because it denies the existence of high cognitive processes and abilities, but rather because it places them in continuity with perception. And second, by sketching this ecological view of cognition as an extension of perception, we have shown how the ecological framework can still capture a variety of important cognitive phenomena and make sense of ordinary psychological experience. Even though we have not explicitly argued that ecological psychology gives a better overall account of cognition than its competitors, our argument shows that, at the very least, ecological psychology has been more successful in fulfilling the basic task scientific theories have of advancing our understanding by providing clear correctives for folk psychology.

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