Zakaria Djebbara *Editor*

Affordances in Everyday Life

A Multidisciplinary Collection of Essays

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Preface

The Ecological Approach to Visual Perception (1979) is a highly influential book by James J. Gibson that explains the ecological reasoning behind action and perception by referring to *affordances* as what the environment provides or furnishes to animals, for good or ill. Affordances are perceptions describing the complementarity between the physical structure of the environment and an animal's capabilities for interaction. If affordances are generally conceived as a relationship between two adaptive and interacting systems, then the term gains broad applicability as it embodies and characterises *interactability* relevant to the biological, social and technical sciences. Perhaps for that reason, the concept has proven exceedingly valuable for fields outside ecological psychology. However, in its integration with other fields, the meaning and purpose of the term have been extended and moulded to fit the customs of these adapting fields.

It was with the aim to provide a better understanding of the development, the distinct meanings and the boundaries between various definitions of the term *affordance* that this collection of essays has been established. In an age where the term has gained a greater amount of nuance and is being used in increasingly sophisticated ways across disciplines, the present collection of essays provides what has not been attempted before, namely, an accessible overview of the concept's application with limited-to-no field-specific jargon. In their personal essays, each contributor discusses either how affordances have served to understand a specific mechanism or phenomenon or how the concept has shaped or been applied throughout their careers. Thus, this book culminates in a short collection of easily-read essays that attempts to map how the widespread ecological concept has been applied, both theoretically and practically, in numerous disciplines.

The approach here is slightly different from most collections of essays and edited volumes. Most collections of essays focus on a single field, discussing several concepts and directions within that same field – however, by having authors from a variety of backgrounds examine the same theme of *affordances*, this book takes a different approach, serving as a multidisciplinary catalyst to encourage students, designers and researchers of all levels to reconsider the application of the concept.

It is the hope that the essays' accessibility will serve as motivation, provocation and inspiration for new ways to think about and apply the concept.

Although short, this collection of essays contains a total of 19 original contributions by excellent researchers with very different backgrounds. They have been categorized into seven sections ranging from philosophy, psychology and sociology to engineering, architecture and computer science to appreciate the potential of affordances. Surely, this collection of essays does not cover all kinds of affordances. The reader is thus also invited to critically consider the essays and explore what other ways affordances can be applied. Hopefully, these essays will inspire the reader as much as they did to me, the editor.

Aalborg, Denmark Zakaria Djebbara

Acknowledgements

This collection is inspired by discussions with colleagues and friends at the *Situated Mobilities and Sensing Bodies* research group from Aalborg University, the *Berlin Mobile Brain/Body Imaging Lab* at Technical University Berlin and numerous conferences over the years. It is intended to be an interdisciplinary introduction to *affordances* as James Gibson, who coined the term, wrote about it but also beyond. It is my hope that the readers are inspired by the essays and find a way to either apply *affordances* to their everyday lives and/or their research questions.

I am grateful for the thought-provoking discussions about affordances, and the help and motivation to see the collection through from my dear friends and colleagues at different stages: Andrèa Roland-Rodriguez, Ole B. Jensen, Tenna Doktor Olsen Tvedebrink, Lars Brorson Fich, Asbjørn Carstens, Dylan Huynh, Andrea Jelic and Klaus Gramann. I would also like to express my appreciation and gratefulness to my dear authors: Anna M. Borghi, Anthony Chemero, Antonella Maselli, Ditte Bendix Lanng, Erik Rietveld, Gian Luca Lancia, Giovanni Pezzulo, Giuseppe Flavio Artese, Hugo Spiers, Ivar R. Kolvoort, Jelle Bruineberg, Jeremy Gordon, Joel Krueger, Jonathan R. A. Maier, Juan Diego Bogotá, Karl Friston, Klaus Gramann, Kristopher Nielsen, Lara Gregorians, Lukas Gehrke, Madeline Donald, Manuel Heras-Escribano, Marie Frier Hvejsel, Mattia Eluchans, Maxwell J.D. Ramstead, Ole B. Jensen, Paul Cisek, Pedro Lopes, Sergei Gepshtein, Thomas Thiery, Tim Ingold and Tonino Griffero. Finally, I would also like to express my gratitude to my dear wife, Nulvin Bozo, for motivating and supporting me in reading and editing the book numerous times.

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Chapter 1
A Personal Introduction

Zakaria Djebbara

1.1 Introduction

As a student of architecture, nothing was as important to me as space. We studied intensely transformations of spaces, properties of materials, structural capacities of shapes, and the intersection between form and meaning. It was clear. To become an architect, you need to know how to design space. One of the many advantages of being an architect student is the many travels to different countries and cultures throughout your education. Three years into becoming an architect, we went to Japan for a month. I remember this journey vividly. I cannot think of a culture more distanced from my own than the Japanese culture. I was in for a serious culture shock. Everything, including door handles, seats, tables, stores, metro stations, handrails, urban structure, materials, forms, and shapes of buildings, was entirely different from what I knew. This was the first time I experienced an impact of this kind caused by the surrounding environment. Japan left me baffled and speechless—I wanted to understand this fantastical experience, but I did not have the tools. It was upon returning from Japan that I first encountered Lars Brorson Fich, an architect who has become a researcher, at the school of architecture. He is an architect of a different breed. After giving a fascinating lecture on his stress-related research based on an embodied framework (Fich et al., 2014; Damasio, 2010), it occurred to me that this was the first time in three and a half years that a lecture was devoted to the human body instead of the environment. This was radical! And he was clearly right. How could anyone put pen to paper and design the environment if they do not know the potential impact on the users?

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Seeing architecture from his embodied perspective changed my mind and attitude about what architecture is all about. Among my first realisations, I discovered that my interaction with and responses to space are automatic. I do not need to reason about my sensations, actions, or experience of the space to decide on my behaviour or to form an opinion about it (Zajonc, 1980). My behaviour is invited and facilitated by the environmental features while my opinions are formed immediately upon perceiving the space. I know what environment best facilitates my concentration and I know which environment best facilities my hunger for socialising. But, as Lars Brorson Fich ensured, surprisingly little is known about how features of the designed space affect us experientially and behaviourally. Finally, I understood that, indeed, to become an architect, you need to know how to design space—however, to become a skilled architect, you need to know how to design experiences. The former pertains to the concrete and spatial, the latter to motion and time. I wanted to understand how the design of space can create experiences—I wanted to understand how space moves us. That was my call for research.

I entered research without the concept I needed to tie my fascination with how we sense and experience the world with the way environmental features automatically invite specific behaviours. The first time I came across the concept of affordance it was presented to me as the salient feature of either an object or the environment inviting a specific use or behaviour. It was associated with how the saliency of design of things could facilitate certain interactions, for example, the graspability of the handle of a teacup. We would say that the teacup *affords* being grasped. It was only when I read the original work by Gibson that I learned that the perspective I had read earlier was a design interpretation of the concept, mostly made popular by Don Norman in the design world (Norman, 2013). Gibsonian affordances are more general as they relate the living organism to its environment (Gibson, 1986). They are not specifically about the salient features of either an object or the environment—they encompass all of perception. To perceive, according to Gibson, is the *direct perception* of the affordances of the environment relative to oneself.

To be clear, affordances are specified in the perceptual systems, which means that perceiving a door is not simply to sense parts and pieces, like the edges and shape, of the door and then put together a puzzle to form our perception but instead to *directly* perceive the door with its passability. Sensations are not considered individual channels but interrelated perceptual systems that inform one another dynamically in which affordances are revealed directly (Gibson, 1966). There is no need for higher cognitive processing to perceive the meaning and value of the environment—it is readily there in the environment to be picked up. This may seem bewildering. How can affordances reveal themselves directly through the perceptual systems? There must be something about the perceptual systems that carry information concerning affordances. To clarify, let us consider for instance Gibsonian optic array in visual perception.

1.2 Information and Optic Array

First, it is important to note that affordances share an interesting similarity with counterfactuals. Counterfactuals concern the alternative outcomes contrary to the factual outcomes. They concern *what-ifs.* What if I had made a left turn much earlier? What if I were to ride my bike slower over these bumpy cobblestones? What if I lay on the grass? Although a counterfactual thought need not be realistic, it shares with affordances the operation of considering alternative possibilities and their potential outcomes. However, to consider the realistic *what-ifs*, we must afford their possible interactions. Counterfactuals, incidentally, are precisely what characterise *information*. In her splendid book, *The Science of Can and Can't*, Chiara Marletto (2021) dives much deeper into the relationship between counterfactuals and information theory. However, in this introduction, I merely wish to emphasise that for anything to be informative, say for instance about the affordances of the environment, it needs to have one specific capacity and that is to be able to change between different states. Consider Morse Codes. Full sentences can be broadcasted by altering between sequences of long and short signal durations. To be informative, the medium essentially needs to be in one of at least two possible states.

Gibson firmly argued that his take on *information* has nothing to do with carrying nor transmitting information and so it is entirely different from the information-theoretic definition. His take is instead about seeking out and directly detecting features of the environment that are relevant to affordances. The information pickup is factual and physical. In his seminal book, he states:

> The world does not speak to the observer. Animals and humans communicate with cries, gestures, speech, pictures, writing and television, but we cannot hope to understand perception in terms of these channels; it is quite the other way around. Words and pictures convey information, carry it, or transmit it, but the information in the sea of energy around each of us, luminous or mechanical or chemical energy, is not conveyed. It is simply there (Gibson, 1986, p. 242).

To understand this view, we need to return to one of the most important insights of Gibson's ecological approach, namely, his critique of the concept of *stimulus*. Gibson disregarded the existence of stimulus as a discrete, individual package—instead, our interaction with the world is continuous and temporally extended. The word stimulus presumes that it is temporally and spatially distinguishable from the stimulus immediately before and after it, which would mean accepting that there is an instantaneous transition from one stimulus to another followed by a static sequence of responses. This did not sit well with Gibson. Instead, he suggested that there is a flowing array of energy with overlapping and interpenetrating stimuli and responses occluding one another. The stimulus of any moment in time is never isolated or detached from the preceding and incoming array of stimuli—neither are the responses. There is a temporal dimension associated with the array of stimuli, and they continuously change based on body activity, brain activity, and the surrounding environment. But how is this related to the affordances in the optic array, you may wonder.

The optic array describes the arrangement of light angles, structured by the surfaces in the environment given a source of light, that hit the retina at a point of observation. When we move through the environment, there is a continuous perspectival change of the environment, where parts of the optic arrays will either remain variant or invariant, revealing the possible transformation of the detected surfaces. For instance, the expansion of a form specifies that it is (or you are) approaching, whereas the contraction of the form specifies that it is (or you are) receding. Another example is that if a detected texture disappears close to a detected contour, we perceive that as a surface being concealed behind an occluding edge. Notice here that we are not referring to the actual state of the angles, but to how they change. It is in this continuous transformation of optic arrays that our perception of the environment becomes the detection of invariant features in the environment through time and motion.

If the optic array in the environment presents us with variants and invariants, our perception of the environment then depends on the alteration between more than a single possible state that the optic arrays can take. Our automatic responses to numerous feature detections rest on this capacity provided by the optic array—they are revealed in the way perceptual systems change in time. Both invariance and variance in the optic array carry information of the environment, but both invariance and variance are concepts only evaluable under temporal change. For us to know that something is invariant, it must not change in time, while that which is variant needs to change in time.

We now have an informative medium with which we can resonate and tune into our environment. The environment itself is the medium of information in this case. Surely, with an optic array of this nature, it is clear that we need little to no involvement from higher cognitive capacities to mediate our perception of the affordances in the surrounding environment. We are, in other words, directly attuned to the invariant information in the environment. The information pickup is not carrying static content per se but carries *changing* information *for* affordances. As you will encounter throughout this collection of essays, there are different opinions about the relationship between affordances and information—this is but my personal view.

1.3 Movement and Time

As it turns out, there is more in the change of things than in things themselves. We perceive the affordances of the environment because of how things change, that is, how the detected invariant features transform in time and motion. Numerous other thinkers have suggested the tight link between time, movement, and human perception. Particularly in his creative dissertation *An Essay on the Immediate Data of Consciousness* from 1889, Henri Bergson (2001) made an original contribution to our understanding of time and motion. Without diving too deep into his concepts and ideas, I wish to merely highlight his view of how human experience as a process *of becoming* through movement.

His main aim in his dissertation was to disentangle space and time as a response to Immanuel Kant. To Bergson, space and time hold different properties that characterise them. Space is that which is *infinitely divisible*. Anything in space can be continuously divided in the very same sense as infinite geometric series; a cube can be divided in half and juxtaposed infinitely. But time is different. Time is that which is *indivisible*. Any moment *of* time cannot be divided and juxtaposed with another moment *of* time without spatialising time. Space allows juxtaposing and externalising one from another in a homogeneous space, whereas time consists of a temporal heterogeneity where experience gradually becomes richer in content, making any two moments incomparable. To differ in time is to differ in *kind*. To differ in space is to differ in *degree*. You may wonder how these insights are related to movement and experience.

Movement belongs to both space and time, but in different ways (Bergson, 2007). From our quantitative, spatial transformation of the body follows a qualitative, temporal duration of our experience. But to Bergson, movement is indivisible, similar to time. Movement has duration, which, for Bergson, is the continuity of progress with which comes heterogeneity. Therefore, it is through movement that we experience the world and continuously become. All the depths and heterogeneous quality of human experience *become* through the movement of the body in time, so that, in short, through movement experience becomes.

1.4 Enactive Account

Emphasising movement leads us to the circularity found in perception and action, which will essentially lead us to the importance of the relationship between the brain, body, and environment. This circular structure of embodiment, where movement causes new perceptions and perception affords new movements, is critical to the *enactivist* movement, which has several similarities with both Bergson's and Gibson's ecological psychology. It was Francisco Varela, Evan Thompson, and Eleanor Rosch (2016) who coined the term *enactivism*, which refers, somewhat similar to both Bergson and Gibson, to the fact that living organisms participate in the process of generating meaning as they engage in the transformation of the world. It is hard to imagine a world in which our actions and perceptions do not form a symmetric relationship.

In brief, enactivism promotes a view of human experience as meaningful activity in the world; it is a continuous process of sense-making manifested in self-sustaining neuronal, bodily, and sensorimotor dynamics resonating under far-from-equilibrium circumstances. This view essentially borrows several concepts from nonlinear dynamics, network theory, and generally complex systems. What typically characterises complex systems is that they emerge from the collective behaviour of their parts in ways that are difficult to infer from the properties of their parts alone—that is, we cannot understand human behaviour nor experience by merely studying either the brain, the body, or the environment in isolation. The critical argument is that it

is not only local states that can affect global states—global states can also affect local states in a downward causal manner (Thompson, 2007). It is for this reason that enactivism appeals to a more expansive account where the capacities of the living organism emerge from the interaction between the brain, body, and environment.

One particularly interesting framework that subsumes enactivism under their paradigm is the advocates of predictive processing in their attempt to construct a more unified theory of the brain through a *free energy principle* (Clark, 2015). The argument of downward causation in enactivism is interpreted as the capacity to actively generate predictions, based on Bayesian optimisation and an information-theoretic approach, about the states of the world (Friston, 2010). There are several incompatibilities between enactivism and predictive processing that are worth looking into for the interested reader (Di Paolo et al., 2022).

Despite the emphasis on the brain, body, and environment, I was not ready to assign equal importance to the triad in all situations. Several findings suggest that lesions in the brain of impaired patients lead to robust changes in experience and behaviour. In addition, weighing approximately 2% of the average body weight, the brain consumes about 20% of the body's energy. This is nature's way of stating that this organ is doing something important. This was also appreciated by Varela as he continued to pursue a systems approach to neuroscience where Thompson and he argued that we can learn more about the brain's role in behaviour and experience from the large-scale network dynamics and synchronisations than from particular classes or circuits of neurons (Thompson & Varela, 2001). Systems neuroscience has ever since grown into a branch that emphasises the interaction of neuronal structures in networks that impact sensorimotor control and information processing (Sporns, 2011). These interactions provide us with a framework from which to understand how brain structures and functions work together to create behaviour.

1.5 Enactive Neuroscience?

With that said, I realised that I needed to create experiments that allow the monitoring of the brain, body, and environment so they could later be analysed in tandem. By additionally allowing my participants to freely move around, I could obtain what Klaus Gramann and his colleagues (2014) have referred to as *natural cognition*—that is, ecologically valid experimental setups where the participant *acts* and in which we monitor the brain, body, and environment. Bingo! This approach, *mobile brain/body imaging*, was aligning with the view I had built up about human behaviour and experience. On the brain side of things, we essentially arrive at the humble beginnings of what might be named enactive or ecological neuroscience (Parada & Rossi, 2020). After a short one-day visit to Klaus Gramann's laboratory in Berlin, I realised that this is our current best shot at uncovering the relations between brain, body, and environment, and I had to learn from him and his enthusiastic team for at least half a year. In collaborating with Klaus Gramann, we managed to design an

experiment that questions the role of affordances in the processes relevant to action and perception as expounded by the enactive theory.

Combining virtual reality with an electroencephalogram, we designed three different doors with each their afforded passability (Djebbara et al., 2019). The task was then to simply pass through the door and collect a reward from the other room. Two of the doors, although different in width, were passable; however, the third door was impossible to pass. It was simply too narrow to fit the body through—in other words, it did not afford a pass or passage. Analysing the moment they perceived which door they had to pass led to surprising results. It turns out that the affordances of the environment are reflected in early visual processes and motor-related processes. The analyses show that the door that was impossible to pass was processed significantly different from the other two doors, whereas these two other doors did not significantly differ from one another.

It also turns out that during the interaction with the doors, a specific frequency band reflected the affordances of the door over the sensorimotor regions (Djebbara et al., 2021). This suggests that the responses varying as a function of the affordances of the door were not only early responses. They were in fact continuous and persisted throughout the interaction. When we design spaces, we should be aware that architecture is designed to a great extent in time and expectation and not just space alone. The ongoing sensory dynamics can, in fact, alter behaviour in automatic and implicit ways that escape our conscious attention (Djebbara et al., 2022). In a way, our interactive skills are relying, to a great extent, on our expected sensory dynamics, which in turn are designed by an architect. Are architects affecting our everyday behaviour and experience? Indeed, they are. Are we directly perceiving affordances? I am not sure. These results suggest that there may be some hold to this view as affordances are reflected in early perceptual processes, but we are merely at the beginning of uncovering the relations.

1.6 Final Thoughts

In closing, I want to remind the reader of my ambition to become a skilled architect that understands how space moves us. I have yet to succeed for two reasons. First, on a large scale, the concept of affordances helped me answer how architecture is related to human experience and behaviour. This was relevant as architecture is in part about shaping the world so that it fits our physical structure and functional needs. Affordances are what one can do, not what one must do. Surely, certain features of the environment may feel more inviting than others. For example, a chair may invite you to sit while staircases may invite you to climb them. But, in essence, affordances present us with meaningful possibilities for action and because some affordances can feel more inviting than others, the environment can be thought of as a landscape of attractors that, when under the right exploratory circumstances, moves us and consequently designs our experience of space through a trajectory of movements. While the journey towards neuroscience provided me with some

concepts and tools to better understand the relationship between experience and behaviour, I have not yet been able to uncover on a smaller scale how we automatically adapt to the environment and what these adaptations mean for our experience and capacities. How exactly does the bodily interaction with designed space affect the trajectory of our inner flowing of experience?

Second, during my pursuit, I have been ambushed by the fascinating thoughts and complex approaches of several giant thinkers in the history of philosophy, psychology, and science. How they write passionately about their topic, dedicate several years to answer questions that become deeply personal, and intertwine and inspire each other while providing original insights have altogether irreversibly inspired me. Here I acknowledge that I have essentially failed as I no longer wish to become "the skilled architect" as much as I wish to dedicate myself to unravelling questions deeply rooted in my personal wondering and to contribute to our collective story we call science. I wish to dedicate my time and energy to advancing our understanding of how architecture is related to experience—in a way, how space is related to time.

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Part I
Ecological and Philosophical View

Chapter 2
Affordances for Situating the Embodied Mind in Sociocultural Practice

Ivar R. Kolvoort and Erik Rietveld

2.1 Introduction

Much of human daily life is taken up with performing skilled activities in which we engage with the affordances the social, cultural, material, and natural environment provides. Activities as varied as driving, eating, performing surgery, talking, and making works of art can be understood in terms of skilled engagement with affordances. Affordances are possibilities for action provided to us by the environment—by substances, surfaces, objects, and living creatures that surround us (Chemero, 2009; Gibson, 1979; Heft, 2001; Stoffregen, 2003). The concept of affordances applies not only to humans, but to all living organisms, as we all share the fate of being inescapably surrounded by our surroundings.

This broad applicability of ecological psychology and its focus on action is shared by enactivism, an approach to cognition that focuses on the dynamic interactions between an acting organism and its environment. The Skilled Intentionality Framework (SIF) is a philosophical approach that combines insights from both

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ecological psychology and enactivism to understand the embodied and situated mind. With SIF there is the long-term ambition to provide a conceptual framework that applies across the board; to all living organisms, from mollusks to mammals, and to all types of behavior, including so-called *higher* cognition and collective action. SIF radically extends the scope of affordance theory and in doing so aims to offer a parsimonious account of cognition that provides a sound philosophical foundation for understanding the relation between people and their living environment and, moreover, is relevant for neuroscience, biology, the humanities, and the social sciences alike. The aim of this essay is to provide an overview of SIF and the role that affordances play in it. Skilled intentionality is the selective engagement with multiple affordances simultaneously, which puts affordances and the responsiveness to them at the heart of SIF.

A cup affords grasping by us, mostly by virtue of physical facts concerning the size and shape of our hands and cups. However, it is possible to explain so much more than just mechanical action routines using affordances if we understand how affordances are related to sociocultural practices. For example, it makes a difference whether a cup is yours or mine: I will be invited by the possibility of drinking from mine but not from yours. Crucially, we propose that it is possible to understand *all* skillful action in terms of engagement with affordances. To accomplish this the SIF proposes a broad definition of affordances as relations between (a) aspects of the sociomaterial environment in flux and (b) abilities available in a *form of life* (Rietveld & Kiverstein, 2014).

Using this definition allows for an analysis of affordances on multiple scales (e.g., their invitational character for a particular individual as well as the affordances available in a given sociocultural practice) while simultaneously bridging these levels to provide an integrated account of the embodied and situated human mind (this will become clear below). Our aim in this essay is to showcase these strengths of SIF and more generally the strengths of a philosophy of affordances that takes our human situatedness in a social, cultural, material, and natural environment seriously. In particular, first we will discuss the landscape of affordances as our ecological niche. Then we discuss the experience of an individual in a niche structured by affordances. In the third part, we discuss the interrelation of the individual and niche in terms of affordances. And we end by looking at the dynamics within an individual, namely the bodily states of action readiness that affordances can evoke.

2.2 The Landscape of Affordances as Our Ecological Niche

The aforementioned definition of affordances uses the Wittgensteinian notion of a *form of life* (1953), which refers to "the relatively stable and regular patterns of activity found among individuals taking part in a practice or a custom" (Kiverstein et al., 2019). The reason to use *form of life* in the definition of affordances is to be able to account for the highly specialized and varied abilities that humans can embody by being part of particular sociocultural practices. While for most purposes

it seems reasonable to characterize the abilities of all members of the earthworm species as a single set, this approach fails for humans, as the skillsets of different individuals, e.g., neurosurgeons and Maasai hunters, vary strongly (see Ingold, 2000). *Form of life* can thus refer to both sociocultural practices (e.g., those of neurosurgeons or hunters) and to species (e.g., earthworms, kangaroos, humans).

With regard to the environment in which people and other animals are situated, Kiverstein et al. (2019) proposed to distinguish between the level of the individual and the level of a *form of life*. At the level of a *form of life* we can characterize the ecological niche as a *landscape of affordances*. A core idea of the SIF is that the landscape of affordances that surrounds humans is incredibly rich, richer than is generally assumed (Rietveld & Kiverstein, 2014). It is not just that a cup affords grasping; a sad friend affords comforting, this page affords being *described correctly* as white, a surgical room affords a surgeon to do an operation, and a bow and arrow afford the hunter to shoot. Moreover, as affordances are defined relative to a form of life, the existence of affordances is not dependent on the individual. The landscape of affordances is as stable as the patterns of behavior that form our practices. The landscape thus is a stable, shared environment for individuals inhabiting a form of life (see Fig. 2.1a).

The rich human landscape of affordances arises due to the similarly rich relata of our definition of affordances: environmental aspects and abilities available in the form of life. We already touched upon the variety in human abilities; the wide variety of human sociocultural practices entails many different abilities that can be available to human individuals. The other relatum, the environmental aspects, come in even greater variety and are in the human case best understood as being thoroughly *sociomaterial* due to the intertwinement of the material and the social in

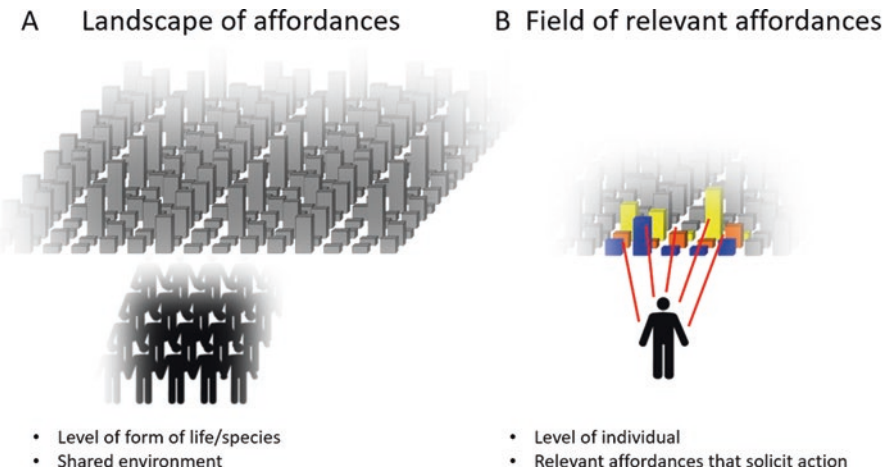

Fig. 2.1 Sketches of landscape and field of affordances, which are relative to a form of life and to an individual, respectively. Note that the landscape and field are both dynamic (see main text). The field and landscape stand in mutual and reciprocal dependence to one another (Kiverstein et al., 2019)

practice (van Dijk & Rietveld, 2017). As humans we are embedded in sociocultural practices, which means that also the material structures around us have been shaped by cultural practices. Wherever you are now, look around and you will see particular objects in particular places, both those objects themselves and the places they are in have been formed by social practices (e.g., this shows itself in that we tend not to put mugs on top of keyboards or keyboards on chairs).

As both our abilities and our environments come about through sociocultural practices, it follows that the landscape of affordances for humans is also fundamentally *social*. The possibilities for action we have depend on the sociocultural practices, i.e., forms of life, we are part of. For example, as part of the sociocultural practice of speaking English, we have the possibility to judge the arguments in this text, to imagine how it could be structured differently, to read out these words aloud, etc. The landscape of affordances in this way reflects the abilities that arise from our practices.

These abilities that arise from our practices include those related to so-called *higher cognition*, such as judging the arguments in this text. While research in embodied cognition has mostly focused on sensorimotor skills, we contend that responsiveness to affordances is not limited to repeating mechanically some routine, but is flexible in a context-sensitive way. The orthodox dichotomy of so-called *higher* and *lower* cognition hence plays no role in the SIF; all skilled behavior is viewed as engaging with multiple affordances, enabling the analysis of all forms of behavior in one framework. This includes activities such as reflecting, judging, imagining, verbalizing, planning, and more (Kiverstein & Rietveld, 2018; Kolvoort et al., 2021; Van Den Herik & Rietveld, 2021; van Dijk & Rietveld, 2021a, b).

We can think of *higher* cognition as part of temporally extended activities in which we coordinate with nested affordances in an environment structured by a complex constellation of sociomaterial practices (Kiverstein & Rietveld, 2018; van Dijk & Rietveld, 2021a).

Crucially, using the form of life as the level of analysis allowed the development of a Wittgensteinian notion of *situated normativity* to describe the normative aspect of cognition in skillful action (Rietveld, 2008). Situated normativity describes the normative dimension of the things we do in real-life contexts. In every concrete situation, an individual distinguishes between better or worse possibilities for action. For humans, this is strongly dependent on the sociocultural practices in which our actions are embedded; whether some action is adequate (or good, correct, etc.) or not is dependent in part upon agreement in action among members of a sociocultural practice (Wittgenstein, 1953). While dancing might be laudable within the confines of a nightclub, it might not be so when engaging in the practice of listening to a client's presentation at a company's office.

2.3 Individual Experience of Affordances

We have discussed that we can describe the ecological niche as a landscape of affordances on the level of a form of life. An important question is how an individual engages with this landscape. As the landscape of affordance is relative to a whole form of life, this question narrows to: How does an individual *selectively engage* with affordances that are relevant to them in their current situation? If we walk into a cafeteria looking for a place to sit and eat our lunch, we tend not to be overwhelmed by the myriad of possibilities that the chairs, tables, and people in the cafeteria afford us. In such a situation, we tend to be drawn in, or *solicited,* only by aspects of the cafeteria that will allow us to sit down and eat.

In SIF *solicitations* are distinguished from affordances (Rietveld, 2008; Rietveld & Kiverstein, 2014), where solicitations are those affordances that are experienced as *relevant* by a situated individual. So these solicitations or *relevant affordances* are to be analyzed at the level of the individual, while available affordances and their existence belong at the level of a form of life.

What makes one affordance relevant but not another? SIF avoids the groundless use of goals or tasks and instead argues for a *process of self-organization* as the source of relevance (Bruineberg & Rietveld, 2014). All organisms tend toward a state of relative equilibrium in the dynamic coupling between their body and the world via "self-organized compensatory activity" (Merleau-Ponty, 2003). It is this tendency that imbues some affordances with relevancy but not others and the SIF characterizes this tendency as a *tendency toward better grip* on the situation. It is those affordances that allow us to improve our grip on the situation that are relevant. Which is why in the previous example we are solicited by what an empty chair affords in a cafeteria, but not by the affordances of chairs with occupants.

However, in real-life we do not engage with only one affordance at a time, Skilled Intentionality implies a responsiveness to multiple affordances simultaneously. We refer to the constellation of affordances that are relevant or inviting to an individual engaging with a concrete situation as the *field of relevant affordances* (Fig. 2.1b; Rietveld et al., 2018; Rietveld & Kiverstein, 2014). The inviting affordances of the field are part of the lived experience of an individual (Withagen et al., 2012), and it is opened up out of the landscape, by their abilities and concerns in the concrete situation. This experience of a situation inviting behavior goes together with a *bodily state* that has been referred to as "action readiness" in emotion psychology (Frijda, 2007), that is, the body poises itself for active engagement with relevant affordances.

Although the landscape of affordances is in flux when considered over larger timescales, the field of relevant affordances is an even more dynamic and ever-changing phenomenon. When an individual acts or when the situation itself develops, the individual–environment relation is changed and other solicitations arise (Bruineberg & Rietveld, 2014). What is foreground and what is background shifts continuously, the field is in *flux* over shorter timescales. Crucially, the individual is responsive to field of relevant affordances *as a whole*. For example, while attending

a presentation, we can be responsive to what is afforded by our cup coffee and the speaker at the same time. And the relevance of what either affords can change due to our own actions (e.g., finishing the coffee, raising our hand) or by the changing environment (a colleague walking in, the presentation ending). Often it will be that being poised for multiple relevant affordances simultaneously allows for an improvement in grip, because it enables one to flexibly and rapidly respond to changes in the environment (Bruineberg et al., 2021).

2.4 The Individual Entangled with the Form of Life: Fields and Landscape as Continuing Process

Now that we have discussed the landscape and field of affordances, we can turn our eye to their complex and dynamic interrelationship. While we can conceptually distinguish shared publicly available affordances and those relevant affordances that invite a situated agent to act, they should not be separated on ontological grounds (Kiverstein et al., 2019). Such an ontological separation would violate the reciprocal and mutual dependence of the landscape and field. This violation becomes clear when we appreciate the fact that while the landscape of affordances incorporates physical and material structure, it is not the reality as described in physics. Instead, the landscape of affordances is pragmatically structured by patterns of regular activity available in an ecological niche or form of life.

For example, while it is indeed a physical matter that we are supported by the floor of a post office, that we often form a single file queue is not just a physical matter (as the physical space would allow a group to stand in a myriad of configurations), but it is a matter of sociocultural practices, in this case the practice of queuing. Queueing is a practice, it is a pattern of regular activity available in a form of life (one that most of us inhabit), hence it is part of the landscape of affordances. However, from the perspective of the individual, queueing is also an act, it is an individual engaging with a relevant affordance. This points us toward the reality that practices and affordances are different perspectives on the same thing. The practice of queueing consists out of individuals who tend toward better grip on their situations by engaging with the affordance to queue. When we take the perspective of one individual who enters the post office, the other individuals queueing form part of the sociomaterial structure around her, constraining her field of relevant affordances. On the other hand, when she joins the queue, she engages with the practice of queueing that is part of the public landscape of affordances available to all the people there.

We chose the example of queueing because of its physicality, as one person queueing (engaging with a relevant affordance) in a very physical sense is both part of a practice (landscape) and a relevant affordance for another person (field), who can queue physically behind her. In a very direct sense the material structure of the landscape (a queue) is here entangled with patterns of an individual's activity. However, this mutuality of practices and affordances is not restricted to physical

(material or temporal) contiguity. For instance, the contours of streets have been shaped by practices of people traveling in different ways (e.g., by foot or car) and by builders placing things in certain places (e.g., traffic lights, sidewalks, buildings), which determine the structure of the landscape for everyone who travels that street, even decades later.

From these examples we can learn that practices and affordances are perspectives on the same sociomaterial entanglement of people, activities, places, and things. Moreover, activities are related to practices in a fundamental sense (van Dijk & Rietveld, 2017). The practice of queueing exists by virtue of individual acts of queueing. The landscape of affordances is formed partly by a history of individual (or joint) activities and continues to take shape as practices unfold. On the other side of the coin, we have that individual acts of queueing depend on the existence of the practice of queueing. The field of relevant affordances opens up out of the landscape.

This reciprocal dependence between the landscape and field of affordances necessitates a view in which an ongoing process shapes the landscape and field together (Kiverstein et al., 2019; van Dijk & Rietveld, 2021a). This ongoing process is comprised of the activity of individuals: Individuals, enacting relevant affordances, simultaneously shape their field of relevant affordances as well as contributing to sociomaterial practices that shape the landscape of affordances (which in turn will shape the future history of activity of individuals). This process view points toward a temporal view on the relation between the landscape and field of affordances (Kiverstein et al., 2019). On short time scales, the more stable landscape constrains the affordances available in the more dynamic field. For instance, the affordance to queue when one gets to the post office is made possible by existence of the practice of queueing, which exists on a larger temporal scale than a particular individual engaging with the affordance to queue. Over longer periods of time, however, the landscape depends on the field of relevant affordances. Practices are maintained over time by the inviting character of affordances leading to activities constitutive of the practice. The practice of queueing is maintained by virtue of the soliciting character of the affordance to queue to individuals. Individuals queueing keep the practice of queueing "alive." In this way,the field, which invites individuals to act in concrete situations, is "at the forefront" of the evolving landscape, continuing it through time, maintaining it how it is, or evolving it in new directions (Kiverstein et al., 2019; van Dijk & Rietveld, 2021a). Kiverstein, Van Dijk, and Rietveld offer the example of musicians making jazz: "the affordances of musical instruments to make jazz music depends upon musicians that know the history of jazz, and can maintain this history whilst also building on it through their own improvisations." (2019, p. 2293).

It is important to note that some of the real-world examples we discussed above (e.g., queueing) can perhaps be considered somewhat trivial. These examples were chosen to be familiar and accessible, but considering our claim that all skillful activities can be understood in terms of engaging with affordances, one can expect SIF to be able to do more. One (not so familiar) example of applying the SIF is the analysis of the field of relevant affordances of patients receiving deep brain stimulation (De Haan et al., 2013). More generally, to understand complex and temporally

extended engagements in terms of affordances requires the methods of embedded philosophy and longer-term ethnographic observation. Examples of using these methods combined with the SIF include the practices of psychiatry (van Westen et al., 2019, 2021), visual art, and architecture (Rietveld & Brouwers, 2017; van Dijk & Rietveld, 2021a, b).

2.5 Within the Individual

So far we have regarded an individual's actions and the dynamics of a developing situation as impacting the individual–environment relation, but the SIF also connects these phenomena with the ongoing dynamics *within* an individual's body and brain. Employing principles from the complex and dynamical systems literature, the SIF relates phenomenology and ecological psychology to developments in theoretical neurobiology (see Bruineberg et al., 2018; Bruineberg & Rietveld, 2014, 2019).

The improvement of grip on a situation can be characterized as the reduction of disequilibrium in the *brain–body–landscape of affordances* dynamical system. Organisms selectively engage with those affordances that reduce their disequilibrium with the environment. The SIF views this disequilibrium as a *dis-attunement* between internal and external dynamics, i.e., between self-organizing affordance-related states of action-readiness in the individual and the changing landscape of affordances (Bruineberg & Rietveld, 2014). It is this dis-attunement that as a most basic concern drives organisms to selectively engage with relevant affordances. On SIF's view, Friston's Free Energy Principle (2010) is all about improving grip on the field of affordances; a reduction in free energy is a reduction in dis-attunement of internal and external dynamics (Bruineberg et al., 2018; Bruineberg & Rietveld, 2014).

Importantly, this conceptual scheme allows for cross-fertilization between disciplines: the study of activity in the brain and body can inform and be informed by investigations of an individual's landscape of affordances (including the embedding sociomaterial practices, which can be investigated well by means of ethnography, see van Dijk & Rietveld, 2021a) and the structure of the field of relevant affordances (which incorporates the individual's abilities and can be investigated by means of phenomenological interviews, see, e.g., De Haan et al., 2013). Overall, we contend that to understand the situated mind, we need to regard the whole system "brain–body–landscape of affordances."

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Chapter 3
Affordances and the Logic of the Gift

Madeline Donald and Jelle Bruineberg

3.1 Introduction

All that is afforded to us by our environments is thanks to Land,[1] the beings, assemblages, and relationships that make ongoing life possible. In this chapter, we offer a reflection on how affordance theories portray Land relations and how thinking with Indigenous philosophies of the gift could help anchor these relations beyond human life-affirming practices.

Both authors of this piece are presently (re)configuring their relationship to Land. Madeline Donald is in the Okanagan watershed, learning with the Land and the peoples of the Land that daily make her life possible. Born a visitor in Coast Miwok territory and raised a traveler, she developed as a student and researcher of human–plant perception. Madeline recently moved from the Netherlands to Canada, a nation-state that welcomes her as a citizen by passport, whiteness, and probable economic utility. This was an intentional move back to stolen Land derived from a desire to think and work with(in) settler colonial trouble while conducting a PhD project in support of the Land's well-being.

[1] We choose here to capitalize Land. Capitalized, this concept encompases not only a material, terrestrial understanding of land but "all the stuff that makes a place a place and not another place, from spirits down to dirt" (Liborion in Harp & Callison, 2021).

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Jelle Bruineberg, a philosopher of cognition working on affordances, was set to migrate from the Netherlands, the country in which he was born and lived in for the majority of his life, to Australia when the pandemic made international flights impossible. For the last 18 months, he has been working remotely from the Netherlands. His (re)configuration to Land came to the fore when he organized a workshop. As is policy at Macquarie University, any workshop starts with an Acknowledgment to Country, a brief ceremony that acknowledges the traditional custodians of the Land on which Macquarie is based: the Wallumattagal clan of the Dharug nation. Speaking from a houseboat in the Netherlands, having never been to Australia, he struggled to find a way to sincerely acknowledge the custodians of Land that felt so abstract and far away.

Our irregular conversations began some years ago with a discussion of the potential use of the term affordance in ethnoecology. Bruineberg had written his dissertation on affordances in embodied cognitive science (Bruineberg, 2018) and Donald chanced across the phrase after conducting research into human use of non-crop plants in and around Trinidad's cacao agroforestry systems (Donald, 2019). Affordances, the possibilities perceived by a form of life for interaction with the surrounding environment, she realized, could be a symbolic container for human–plant interaction. Soon, however, the concept of affordance itself came under scrutiny in our conversations. What conceptual baggage comes along (explicitly or implicitly) with the notion of affordance? What kind of relationship to Land does it signify?

3.2 Affordance Theory and Extraction

James Gibson (1979) characterizes affordances in the following way: "[t]he affordances of the environment are what it *offers* the animal" (p. 127), e.g., the house offers shelter. There is a relational element implied by this view of affordances. Depending on their size, shape, and needs, shelter is not offered to all animals equally: affordances are just there as resources of the environment *relative to* a particular animal.

To describe the intentional relationship between animals and affordances, the term *solicitation* is introduced (cf. Withagen et al., 2012). Solicitations are those affordances that invite engagement. In Gibson's (1979) chapter "The Theory of Affordances," he approvingly quotes Koffka: "Each thing says what it is. ... a fruit says 'Eat me'; water says 'Drink me'; thunder says 'Fear me'; and woman says 'Love me.'" (p. 138). "The object offers what it does because it is what it is" (p. 139), Gibson writes; each thing calls out to be used. Although the relationship between Koffka's notion of demand character and Gibson's notion of affordance is complex, this is a crucial insight that Gibson retains.

Combining these two ideas, affordances as available resources, and solicitations as calling out for use, there emerges a problem. Coming from the environmental humanities, Gibson's assertion reads as an expression of extractive logic:

paraphrasing Koffka: "World says: exploit me." Extractive logic reinforces the idea of uni-directional offering, a taking without reciprocity; humans can *use* the affordances of the environment as they see fit (Shapiro & McNeish, 2021). Moreover, Koffka's quote easily reads as an externalization of responsibility: "forest says 'cut me,'" "coal says, 'burn me.'" "Each thing says what it is" (Koffka, as quoted in Gibson, 1979, p. 148), a resource to be used. We are currently witnessing the ongoing horrors of these logics of extraction: deforestation, skyrocketing greenhouse gas concentrations, and ecological degradation. Recent authors have tied the ideologies in which such extractive practices are rooted to colonialization and rape culture (Bowman, 2017; Davis & Todd, 2017; Holmes et al., 2015).

Is ecological psychology, and its notion of affordance, really so intimately linked with a logic of extraction? We are not sure. Some ecological psychologists have stressed that the direct, unmediated *perceptual* availability of affordances easily slips into taking for granted the availability of affordances *in the world* (i.e., Costall, 1999; Van Dijk, 2021). In other words, it is important to distinguish between the claim that affordances are independent of mental activity and the (problematic) claim that affordances are independent of any sort of activity. Our point is that *if* affordances are portrayed as always already being in the environment, lying ready for use, then that theory of affordance and solicitation easily slips into the logic of extraction. We think it is both worthwhile and possible to preserve what is important about a theory of affordances while grounding it in alternative logics. In this sense, our chapter should be read more as a call for vigilance than as a diagnosis of the current theory landscape.

As an example of non-extractive affordance relationships we borrow insights from Rauna Kuokkanen's (2007a, b; Sami) articulation of a "logic of the gift" and two Indigenous[2] creation stories, one Syilx and one shared by many Indigenous Australian peoples. These three teachings share an underlying ethic of gratitude and reciprocity from which we believe affordance theories have much to learn.

3.3 Toward an Alternative Logic

Rauna Kuokkanen (2007b) writes of "the gift logic of Indigenous philosophies,"[3] logics of responsibility and reciprocity that characterize Indigenous Land ethics around the world. What might a more ontologically flexible theory of affordances look like if grounded in "a perception of the natural environment as a living entity

[2] The term Indigenous refers to communities of people who are *of* a place; as Melissa Nelson (2008) has written, "we cannot be separated from these places … we become one, literally and metaphorically, with our homelands and territories" (p. 10). The word in English is a product of settler colonialism and distinguishes settlers from those whose Land we/they occupy.

[3] While drawing out similarities between different Indigenous philosophies to articulate "the gift logic," Kuokkanen (2007a) is careful to explain that articulating and learning from these similarities do not diminish the diversity of Indigenous philosophies around the world.

which gives its gifts and abundance to people *if* it is treated with respect and gratitude" (ibid., p. 71, emphasis added)?

In his book "Why Indigenous Literatures Matter" (Justice, 2018), writer, thinker, and professor Daniel Justice (Cherokee Nation) explains how relationality, and particularly the oft-cited concept of "all my relations," is inextricable from a logic of the gift. Justice cites Robin Wall Kimmerrer (2013; Citizen Potawatomi Nation):

> Cultures of gratitude must also be cultures of reciprocity. Each person, human or no, is bound to every other in a reciprocal relationship. Just as all beings have a duty to me, I have a duty to them. If an animal gives its life to feed me, I am in turn bound to support its life. If I receive a stream's gift of pure water, then I am responsible for returning a gift in kind. An integral part of a human's education is to know those duties and how to perform them. (p. 87)

"If we don't know these duties," Justice goes on to explain, "it's part of our ethical obligation to learn them, and to express them in a way that makes possible better, healthier, more respectful relations" (p. 87). How might we hold this obligation in relation to a theory of affordances?

We wish for a theory of affordances in which respect and gratitude are fundamental relational necessities, a theory that can support and affirm life and livelihood in complex multi-species assemblages. While cautioning against the pervasive extractive tendencies of the euro-centric academy, Doleen Manning (2017; Anishinaabe) clarifies the importance of engaging with Indigenous philosophies: "These urgently needed alternatives provide a ground from which we can imagine other ways of thinking and being" (p. 18). Heeding Manning's caution and in response to her call, we turn below to two Indigenous creation stories, which are embedded within the respective philosophies[4] from which they have been shared.

3.4 Stories of Relationality

Stories organize cultures, economies, ideologies, theories of change, and fields of study (King, 2003; Liboiron, 2021; Strathern, 1992). According to this understanding of stories, scientific theories are themselves a form of story and scientific practice a form of storying (Phillips & Bunda, 2018, p. 5). We present these stories in order that we may learn from and with them and those philosophies of which they are a part. In so doing, we hope to illuminate possibilities that lie within these rich conceptions of relationality and reciprocity.[5]

[4] Here Indigenous philosophies are taken to mean: ways of being, knowing, and responding that are embedded in story, song, poem, and prayer, and grounded in patterns, processes, and peoples of particular Land (Manning, 2017).

[5] There are more relational understandings to be found in the ecological psychology literature as well (Heft, 2001; Van Dijk, 2021). It is an interesting open question to investigate how the notions of relationality relied on in affordance theoretization compared to the notions of relationality in Indigenous philosophies.

We recognize the importance of humility in engaging with the stories we are citing here; neither of the two authors of this chapter identifies as Indigenous,[6] and these are not our stories. These are stories of place, rooted in the Land from which they have emerged. As such, we quote from versions that have been published in print and widely distributed. We recommend that those interested in extended versions of these stories seek out the writings and/or storytelling of those who hold these stories in their bones.

3.4.1 Food

The story "How Food Was Given" is one of the stories shared most widely throughout Syilx territory.[7] We quote here from a version published in the book "We Are the People: A Trilogy of Okanagan Legends" (Okanagan Tribal Council, 2017). This story details "the world before this world," when "everyone was alive and walking around like we do" (p. 10).

"All Creation talked about the coming changes to their world. They had been told that soon a new kind of people would be living on this earth" (p. 10). In preparation for this, the animal and plant people met "to decide how the People-To-Be would live and what they would eat" (ibid.). Black Bear, Chief for all creatures on the land, Spring Salmon, Chief for all creatures in the water, Bitterroot, Chief for all things underground, and Saskatoon Berry, Chief for all things growing on land, are "the four Chiefs for all Creation" (p. 13). The Chiefs thought and thought, over the course of many meetings, about what they could give the People-To-Be to eat that was already here on earth. Bitterroot, Salmon, and Saskatoon Berry placed their trust in Bear, as the oldest and wisest among them to make a decision: "I will have to do the best I can," said Bear, "I will give myself, and all the animals I am Chief over, to be food for the People-To-Be" (p. 17). Following suit, the others agreed, they too would give themselves and their kin to help nourish the People-To-Be.

"Chief Bear was happy because there would be enough food for the People-To-Be. Bear said, "Now, I will lay down my life to make these things happen"' (p. 25). Healing in that world was a practice of song: "They all took turns singing, but Bear did not come back to life" (p. 26). Finally, Fly came to sing a powerful song, which brought Bear back to life. "Then Fly told the four Chiefs, "From now on when the People-To-Be are here and they take your body for food, they will sing this song. They will cry their thanks with this song"' (p. 27). Bear then spoke for all

[6] Donald works with Syilx collaborators, the people of the Land with which she lives and conducts her research. Her ethics and research praxis have been heavily influenced by scholars of Indigenous methodologies, both Syilx and of other Lands, and as a result, she works within an anti-colonial conceptual framework that stems from Syilx priorities for Land and research.

[7] Syilx Land is currently occupied by the province of British Columbia in Canada and the state of Washington in the USA, approximately 400 km inland from the Pacific Ocean.

the Chiefs, "everything will have its own song. The People-To-Be will use these songs to help each other as you have helped me"' (ibid.).

The story finishes:

> That is how food was given to our people.
>
> That is how songs were given to our people.
>
> That is how giving and helping one another was and still is taught to our people.
>
> This is why we must respect even the smallest, weakest person for what they can contribute.
>
> That is why we give thanks and honor to what is given to us. (p. 30)

"How Food Was Given" tells of how humans, the People-To-Be, came to be able to live and eat here on earth: through generosity and sacrifice. Every human act of nourishment is a result of another lifeform having given over the life or life-giving capacity of themselves or their offspring. Think, for instance, of bread, made from the seeds of grasses who produced those seeds for the purposes of their own reproduction; milk, food produced for one's own offspring and taken by another; or leaves, where plants hold the capacity to nourish themselves.

"That is why we give thanks," the story tells us. The simple and profound practice of giving thanks opens up the possibility to think otherwise about affordances as offerings of the environment. Let us start by reconsidering Gibson's statement that affordances are what the environment offers the animal. In "How Food Was Given," offering is not a mere possibility but an active gift: the animal and plant people *decide* to give their life to nourish humans. When Chief Black Bear says: "eat me", this is not an expression of "what it is," but an expression of what it offers itself as food for the People-To-Be to survive.

Importantly, receiving a gift is different from buying something. A purchase involves the exchange of something of ostensibly equal value. Receiving a gift, on the other hand, requires a different kind of reciprocity. Gifts are unproblematically asymmetric by nature. In the Syilx story, the gift of food is something that the People-To-Be reciprocate by "giving thanks and honor to what is given." This is not an "equal" offering but recognition and reciprocal statement of gratitude.

3.4.2 Water and Fire

Second only to air, water is that which has the most influence in and over our lives. This may not seem to be the case if the tap in your domicile has always afforded on-demand potable water; take that affordance away however, and this truth will be all too clear.

On the continent of Australia, Indigenous stories of the Rainbow Serpent tell of water above and below visible land (Rose, 2005). Oodgeroo Noonuccal and her son

Kabul Oodgeroo Noonuccal (Noonuccal & Noonuccal, 1988; of the Noonuccal people of Minjerribah) call the Rainbow Serpent, "the giver and taker of life" (p. 373). Citing the same constellation of creation stories, Alexis Wright (of the Waanyi nation of the southern highlands of the Gulf of Carpentaria) begins her novel "Carpentaria" with a description of how the rivers and groundwater channels were made:

> Picture the creative serpent, scoring deep into – scouring down through – the slippery underground of the mudflats, leaving in its wake the thunder of tunnels collapsing to form deep sunken valleys. The sea water following in the serpent's wake, swarming in a frenzy of tidal waves, soon changed colour from ocean blue to the yellow of mud. The water filled the swirling tracks to form the mighty bending rivers spread across the vast plains of the Gulf country. The serpent travelled over the marine plains, over the salt flats, through the salt dunes, past the mangrove forests and crawled inland. Then it went back to the sea. And it came out at another spot along the coastline and crawled inland and back again. (2006, p. 1)

As told by Noonuccal and Noonuccal (1988), "We say the earth is our mother—we cannot own her, she owns us. This rock and all these rocks are alive with her spirit. They protect us, all of us" (p. 373). Water and rock shape one another.

Noonuccal and Noonuccal (1988) ask and answer the question that guides this chapter: "How does one repay such gifts? By protecting the land" (p. 373). Protection, however, can be interpreted in innumerable directions with often conflicting mandates (Carroll, 2014; Grego, 2015). The European Environment Agency, for example, defines "nature protection" as

> Precautionary actions, procedures or installations undertaken to prevent or reduce harm to the elements of the material world that exist independently of human activity. (GEMET, n.d.; emphasis added)

In the European context, nature is what happens when humans are not involved. Protection then takes the shape of *not interfering with*, of letting things be. In Indigenous Australian contexts, protection takes a very different form. Gammage (2011) details the active management of Land predominantly through the burning of vegetation. The burning of vegetation not only prevented the outbreak of uncontrollable fires but also shepherded grazing animals and regenerated vegetation: "a planned, precise, fine-grained local caring" (p. 25).

These careful and caring fire management practices are intertwined with ceremony. Mick Bourke (Yorta Yorta and Dja Dja Wurrung) writes,

> When we go to a cultural burn, we do a welcome at the start with a small fire and smoke. This is to let the old folks, our ancestors, know we are on Country so then they can guide us. People need to understand that cultural fire is not just about burning Country, lighting it to reduce fuels, reduce risk to houses, or things like that. We use fire to put colour back into the landscape, as well make our ceremony, connect with each other, connect with our history, and that's just the start. (Bourke et al., 2020, p. 547)
>
> We know that if you care for Country then the Country will care for you. (p. 546)

This shows how practices of protection and care are reciprocal. These practices of care are embedded in and perpetuated by ceremony and the origin stories that are passed down through generations. In "the Rainbow Serpent," the gifts are

reciprocated by protection and taking care. Protection of Land[8] is not understood as leaving Land untouched, but as active land management through, for example, practicing controlled burning. Attending to practices of care can make us question the widely held assumption that the affordances of the environment are there independent of human activity. Only when Land is cared for and protected will the country continue to offer its affordances.

3.5 Conclusion

Elements of a logic of extraction can easily be read into canonical formulations of affordances: they are offerings of the environment that call us out to use them. In this chapter, we have thought with gift logic and two creation stories to explore a different conceptual footing for a theory of affordances.

Following a logic of the gift, the primary affordance relation is not one in which "World says: exploit me," but in which "World says: care for me, so that I can care for you": *only* by caring for Land will Land continue to offer its affordances. Alongside the fruit that says "eat me," the fruit tree says "water me" and "thank me." In the literature on ecological psychology, there has been an overemphasis on the "eat me" kind of solicitations and too little attention to the "water me" and "thank me" kind.

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[8] We choose to use the word Land for consistency. Country, as quoted, "is the Aboriginal English word which encompasses this vibrant and sentient understanding of space/place which becomes bounded through its interconnectivity. Country and everything it encompasses is an active participant in the world, shaping and creating it" (Bawaka Country et al., 2015, p. 270).

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Chapter 4
A Path to Ecological Psychology

Anthony Chemero

4.1 A Path to Ecological Psychology

When I started working toward my Ph.D. in philosophy and cognitive science, I was already skeptical about mental representation. This skepticism was inherited from my undergraduate mentor Daniel Dennett and, even more so, from reading the word of his mentor Gilbert Ryle. For this reason, work in robotics by Randy Beer (2000) and Brooks (1999) was music to my young ears. These two roboticists claimed, and had functioning robots to show, that computational manipulations of representations of the environment actually hinder the development of effective mobile robots. Brooks explicitly claimed that his robots had nothing to do with "German philosophy", but a paper by Beth Preston (1993) convinced me otherwise and led me to Martin Heidegger, which led me eventually to Maurice Merleau-Ponty. All this occurred while I was still enmeshed in working on philosophical issues in cognitive science. At a certain point, I wondered how Heidegger and Merleau-Ponty would try to do cognitive science. This is what led me to read James Gibson. What led me to become very serious about ecological psychology was a job. I was hired at Franklin and Marshall College in Pennsylvania as a replacement for the great, tragically short-lived ecological psychologist Edward Reed, and I had promised during my interview that I could teach his course called "Ecological Psychology." I spent the six months between being offered the job and starting it reading Reed and Gibson, trying to make myself into someone who could teach that course. In doing so, I fell in intellectual love.

I was in love, yes, but still a philosopher. As Jerry Fodor put it, "many philosophers secretly harbor the view that there is something deeply wrong with psychology, but that a philosopher with a little training in the techniques of linguistic

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analysis and a free afternoon could straighten it out" (1968, vii).[1] My aim was to try to do for ecological psychology what Fodor attempted for cognitive psychology. Neither of us succeeded, but I recount my efforts here, after presenting a little history. James Gibson died in 1979, soon after publishing the *Ecological Approach to Visual Perception* (1979/2014; *EAVP*). When it came under immediate attack, including by Fodor (Fodor & Pylyshyn, 1981), it was left to others to defend Gibson's ideas. Michael Turvey, Robert Shaw, William Mace, and Edward Reed (1981) produced a detailed reply to Fodor and Pylyshyn, in which they set out detailed formal and conceptual structures to make Gibson's sometimes impressionistic text into the foundation for a rigorous science. This paper is an undeniable masterwork and has led to decades of excellent science. But from my point of view, it was problematic in that it interpreted Gibson's text so that it was less compatible with the ideas of Merleau-Ponty. I understood Gibson's project as being aligned with Merleau-Ponty's phenomenological philosophy, an understanding that is partially confirmed by the fact that the archives at Cornell contain Gibson's detailed notes on *The Phenomenology of Perception*, which he read while writing *EAVP* (Mace 2014).

In any event, I spent a series of free afternoons trying to develop an alternative reading of Gibson's ideas. The two key differences between my elaboration and that of Turvey and colleagues concerned the ontology of two key concepts from Gibson's text: information and affordances. I will focus on the latter and will just say a few things about the former. For Gibson, perception is the use of information in the environment to guide behavior without intervening representations. Gibson frequently, but not always, discussed information in terms of *specification*. Think of the way a contract specifies outcomes in that it guarantees that those outcomes will come to pass. Gibson thought this was the relationship between information in, say, light and objects in the environment. Having reflected off an apple, the light that hits my eyes over time specifies the presence of an apple. Turvey and colleagues spelled this out in terms of a 1:1 relationship between the structure in light and objects in the world. If the structure in the light was 1:1 related to the presence of an apple, then the light could carry information about an apple. Rob Withagen and I argued that this relationship is too strict and that structures that are merely correlated with entities in the environment can also carry information about those entities (Withagen & Chemero, 2009, 2012). Our intent was to make it such that there was more information available to perceivers to guide their action, including so-called *representation-hungry* actions (Bruineberg et al., 2019). Because this is a book about affordances, I will leave the discussion of information at that.

Gibson is most known for his concept of affordances, which he defines multiple times in his 1979 book, and not always in the same way. The most basic formulation is that affordances are opportunities in the environment available to any creature that can perceive and act on them. Turvey and colleagues defined affordances as dispositional properties of entities in the environment, which were complemented

[1] Thanks to Matt Bateman for helping me find this quote.

by dispositional properties of actors; the environmental dispositions are affordance, while those of actors are what they called *effectivities*. This struck me as at odds with Gibson's most widely discussed description of affordances.

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

Turvey and colleagues define affordances as objective, physical properties of the environment, which does not respect Gibson's claims that they are both subjective and objective, psychical and physical, or neither. But it does do several other useful things. Here are two. First, it is utterly unmysterious in the way that Gibson's formulation is not and, because of this, seems more appropriate for the foundations of scientific psychology. Second, in what Reed (1996) calls the "fundamental thesis of ecological psychology," having affordances be properties of the environment allows them to be the driver of evolution by natural selection. Affordances exist in the world; animal species evolve to be able to take advantage of them.

In contrast, I argued that affordances are relations between an animal's abilities to act and a situation in the world (2003, 2009). Affordances, on this view, are neither properties of the environment, nor properties of the actor; instead, they are the way actors fit into environments. This has neither of the benefits mentioned above that the view of Turvey and colleagues does. It is somewhat mysterious, and it takes affordances out of the evolutionary processes. It has other advantages, though, the most important of which is that it is more faithful to Gibson's intentions. Like Merleau-Ponty, Gibson was strongly influenced by Gestalt psychology. Gibson was a colleague of Koffka as a young professor at Smith College, and Koffka's influence is clearly visible in Gibson's early work (e.g., Gibson and Crook 1938). Written around the same time, Merleau-Ponty's first book *The Structure of Behavior* (1942) is primarily a meditation on the philosophical consequences of Gestalt psychology in which he says that "The world, inasmuch as it harbors living beings, ceases to be a material plenum consisting of juxtaposed parts; it opens up as the place where behavior appears" (1942, 47). We could translate this into Gibson's terminology: a world with actors in it is a world of affordances. But this translation does not work if we take affordances to be dispositional properties of the environment. Moreover, and this is explained in great detail in Harry Heft's monumental *Ecological Psychology in Context* (2001), Gibson considered himself to be a Jamesian radical empiricist. During this late-career era of theorizing, James argued for two key points: that relations are key parts of our experience and that there was not any ontological distinction between the physical and psychical.

Although I would argue that the relational understanding of affordances makes better sense of Gibson's intentions, most practicing ecological psychologists think I am wrong, and even that I am ruining ecological psychology as a science. The primary reason for this is that nearly every practicing ecological psychologist had their Ph.D. directed by Turvey or Shaw or someone whose Ph.D. had been directed by

Turvey or Shaw. (They have been extraordinarily influential.) At the same time, however, the differences between my view of affordances (and information) and theirs are not empirically consequential. That is, you would do the very same experiments and expect the very same results whether affordances are relations or dispositional properties of the environment.[2] In fact, these views are quite similar, and their small differences pale in comparison to the differences between them and the cognitivist theories of affordances that take them to be some kind of mental projection onto the world (e.g., Norman, 1988). Turvey and I agree on this (Chemero & Turvey, 2007). So this difference seems to be *merely* philosophical, the kind of thing to argue about at the pub or in philosophy papers but best kept out of the lab.

This is where the debate has been for a while now: some people think affordances are relations; some people think they are dispositions; differences of opinion on this are not barriers to collaboration. More recently, though, Ed Baggs has convinced me to see things slightly differently (Baggs & Chemero, 2019, 2021). The relational and dispositional views are both valuable, and for different purposes. In order to introduce his notions of information and affordances, Gibson distinguishes between the physical world and the ecological world. The physical world is just what it sounds like, and the ecological world is mesoscopic sub-parts of the physical world that are relevant to perception and action. When Gibson talks about the affordances that exist in the ecological world, he routinely shifts between the affordances for an idealized type of some kind of animal (the affordances for dogs) and the affordances for individuals (the affordances for me). These are not the same thing: apples afford eating for any human with the right kind of abilities; this particular apple is mine and affords eating only for me. Baggs and I proposed to signal this distinction by pointing out that Gibson distinguished between two things when he should have had three. Instead of just the physical vs. the ecological works, he should have distinguished between the physical world, the habitat for a particular species, and the umwelt of an individual actor.[3] The apple affords eating in the habitat that you and Satoshi share, but only in his umwelt.

This distinction of kinds of affordances allows us to see the value of both affordances as relations and affordances as dispositions. If you are trying to make sense of the world as experienced by an individual actor, like when you are doing phenomenology, you are interested in the affordances in their umwelt. If you are trying to design a psychology experiment that a whole range of people can participate in, you are interested in the affordances of the human habitat.[4] Gibson did both, and both are important projects. He just should have used more terms to do them.

That was history. Here is how I see research on affordances going forward. In most papers about affordances, including this one, the example affordances are

[2] You might have heard otherwise on Twitter. Don't believe it.

[3] Elmo Feiten (2020) argues that Baggs and I, along with many other embodied cognitive scientists, are not using the term "umwelt" in its original von Uexküllian sense. He is probably right about that.

[4] There is a potentially slippery slope toward ableism lurking here. The habitat has to be understood in terms of the statistically average member of the population, which is not the same as the "normal" member of the population.

those we have names for, even if sometimes the names are tortured constructions. We talk about affordances like edible, climbable, sit-on-able, and the like. This is partly just laziness, but it is also misleading in that it paints too static a picture of the world that we live and act in. Consider two examples of what we might call *dynamic affordances*.

1. Imagine Satoshi walking home on a rainy afternoon. The wet sidewalk affords walking, of course, but not in the same way as it would when it is dry. When he arrives home, he walks up the wet concrete path to wet wooden stairs, which have another different affordance for walking, and then to the dry wooden porch, covered by a roof. Inside, he takes his shoes off and perceives yet another type of affordance, this one for walking in socks on carpet, and another when he steps onto the wood floor. Each of these situations requires Satoshi to respond to subtly but importantly different affordances, and he does so automatically and seamlessly.
2. Imagine that Satoshi wants to take two different kinds of vitamin. The bottle is graspable, yes, but graspable with a particular hand and wrist orientation. He twists the top off with his other hand and shakes the tablets into his hand. The pills in Satoshi's hand are also graspable, but not in the same way that the jar was: to put the lid back on the jar, he presses them against his palm with two fingers and uses his thumb and two other fingers to twist the lid back on. The second jar affords grasping the same way the first one did, but this time he needs to open it just with thumb and two fingers. Luckily, the jar has that affordance and also affords shaking pills out onto the part of his palm left over, given that he is still holding the tablets from the first jar.

The point of these examples is that most of the affordances we perceive and act upon are not like edibility or climbability; they are dynamic. In real-time engagement with an umwelt, what is afforded is constantly changing; so, too, are our action capabilities. We navigate this seamlessly. This is where the concept of affordances gets its best grip, in the ways we subtly and successfully change our patterns of action to fit the demands of a changing environment.

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Part II
Ethnographical and Social View

Chapter 5
A Walk in the Park: Affordance as Urban Design Tool for Creating Inhabitable Cities

Ditte Bendix Lanng and Ole B. Jensen

5.1 Introduction

> Affordances are the kind of interactions you can engage in conjunction with a given site or element. For pavement, you can walk on it; you can sit on it; you can drive on it [...] you have to actualize it as this or that. What will it be? It is your choice at any given time. So, in the actualization of things, people may play essential roles. But one should not underestimate the materials: their hardness, their softness, their ability to maintain a shape. All this makes the material a player in a way that is significant, causative not causal. (Rob Shields in Fariás, 2010, p. 297)

In this chapter, we explore the proposition that affordance is an important urban design tool that can help create inhabitable cities for people. The creation of inhabitable cities for people is a core ambition in urban design, resonating the aim of the discipline to formulate responses to situated urban problems by means of spatial strategies and architectural design. From the 1950s, urban design grew as a discipline from an apprehension of the importance of the public realm of cities, the human scale, and the thriving of the collective urban population (Mumford, 2009). Following this core ambition of the urban design profession, urban designers have sought to develop methods and tools for the creation of such cities. These tools must provide alternatives to a city-making method based on the form or function of objectified buildings and spaces, or on structural patterns, and instead foreground the city as an environment for inhabitation. As when Gehl speak of invitations (1971) and Lynch and Hack of fit between environment and behavior (Lynch & Hack, 1984).

In this essay, we follow this proposition and explore the thesis that the concept of affordance can help us do that, in encircling how space, for example, *pushes* us

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Z. Djebbara (ed.), *Affordances in Everyday Life*,
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through, *invites* us to linger, or *embraces* us in tiny rooms (Lanng, 2015). Architecture critic Aron Betsky has articulated that an "architecture of affordances" may hold a promise for the creation of "environments that afford us possibilities, that open and enclose, that respond and give us clues" (Betsky, 2015). As such, affordance may be a tool to approach the design of cities in terms of the "perceived and exploited uses to which we [the urban inhabitants] can put the environments architects create" (ibid.).

In the opening quote above, cultural sociologist Rob Shields offers initiating pointers for the usefulness of affordance to the design of the urban environment. He highlights that affordance targets the *interaction* between a human and the material environment and underlines that this interaction is two-sided, or, we might say, relational. Whereas, on the one hand, subjectivity plays indispensable roles in actualizing the affordances of the environment, on the other hand, also the character and features of the material environment are key to the interaction. The material matters to the ways in which humans can inhabit their environment. The focus on this relational interaction between the designed environment and humans hones in on a design concern for the human being-in space.

5.2 The Concept of Affordance in Urban Design

Environmental psychologist James Gibson writes about environmental affordances, defining them in the following way: "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1986, p. 119). Through Gibson's definition, we see that the concept of affordance addresses the interaction between the animal and its environment. As such, it targets a key concern for urban design: how designed environments relate to humans, more specifically what actions and experiences they make possible.

A study on *Bodies and everyday practices in designed urban environments* by cultural sociologists Monica Degen, Gillian Rose, and Begum Basdas (2010) demonstrates the potential use of the concept of affordance. The researchers have investigated British urban environments to research how bodies inhabit these environments—how various human practices "are made possible" (p. 60) by the interaction of human bodies and the material surroundings. They bring out ordinary moments that happen in urban spaces, such as waiting at a bench or looking at shoes in a shop window. The role of the *designed environment* in those interactions is described as constantly *interacting, supporting, and colliding with human bodies*, whereas the role of *human bodies* in those interactions is to *respond, go along with, or ignore the environmental affordances*.

This speaks to the relationality of affordances. To appreciate relationality, we can turn to psychologist Harry Heft (2010) who argues that perceiving what the physical environment affords is not a uniform process in the minds of people. Rather it happens "where the action is," in the "specific dynamic coupling of a human body and the physical environment" (p. 29). Different humans do not engage with an urban

space in the same ways, and each person may engage in one way with the space in one situation and in another way in a second situation. This suggests that humans read different affordances into the same part of the city fabric, or, in other words, that humans *actualize* affordances in distinct and specific ways at any given time.

Still, the material design of urban space matters, as stated by Shields. Architect Jan Gehl's work with *universal invitations* provides an operational way to understand this. Offered as part of his work on a human-oriented approach to design (1971), Gehl takes outset in the imperative of urban design to invite humans to inhabit spaces. The designed invitations must target "universal" human needs, so that humans find it attractive to be there. According to Gehl, this includes that the urban environment provides opportunities to walk, act, and rest, that it provides protection, e.g., against traffic, and against unpleasant impacts on senses, and that it provides experiences, e.g., of positive climatic impacts, of scale and aesthetics (2016).

Through these sources, we have briefly unfolded ways to approach the city as an environment for inhabitation. Affordance, here, is a conceptual tool to tease out opportunities and qualities for inhabitation in the designed urban environment. In the next section, we engage in a study of affordances of a particular urban landscape to further explore the proposition that affordance can function as an operational tool to approach the design of inhabitable cities. We draw out how affordance attunes the urban designer to the human *being-in space*, and the many actions and experiences that may be afforded in the concrete realities of humans inhabiting urban space.

5.3 An Urban Landscape of Affordances

Consider the urban slope on the photograph (Fig. 5.1). It is part of the castle park in the center of the Danish city of Aalborg. The Castle was built during the period 1539–1555. As it was found unfit for fortification, it was used as the seat of power for the King's provincial governors. Today the buildings house government offices, and the park is publicly accessible. It is one of few green spaces in the city center, used for informal stay and for transit.

5.3.1 Being-In Space

A significant feature of the park is the rampart. As a historical reminiscence, the rampart raises around the castle building wings to the west, south, and east. It is a noteworthy experience to move through the park on the side of the sloped rampart and to climb the slopes. These grassed hills roll down to a planar area with tall urban buildings on the other side. Big trees on the planar area and on the slopes reinforce the remarkable landscaped setting. With foliage, they make a dark green roof as a

Fig. 5.1 Urban slope, Aalborghus Slotspark, Aalborg, 08/07/2019, 6:58 PM. (Photo: Ditte Bendix Lanng)

counterpart to the soft grass underfoot, and they emphasize the feeling of moving through a gorge-like space, and of climbing its side to reach a vantage point.

The remarkable topography of the slopes is one of the defining spatial characteristics of the park. The sheer difference in height between below and above is significant for the inner city of Aalborg. This dramatic topography combined with the relatively small size of the enclosed park and the large trees gives the space a dramaturgical feeling.

5.3.2 *Which Actions and Experiences Does the Urban Slope Afford?*

Based on observations done on several occasions in the castle park, at different times of day and season, we draw forward five ordinary instances of human embodied engagements that the slope appears to afford (Fig. 5.2).

By considering each of the diagrammatic sections depicting the slope from top to bottom, we can appreciate some of its various affordances:

The slope affords a rest at the foot of it;

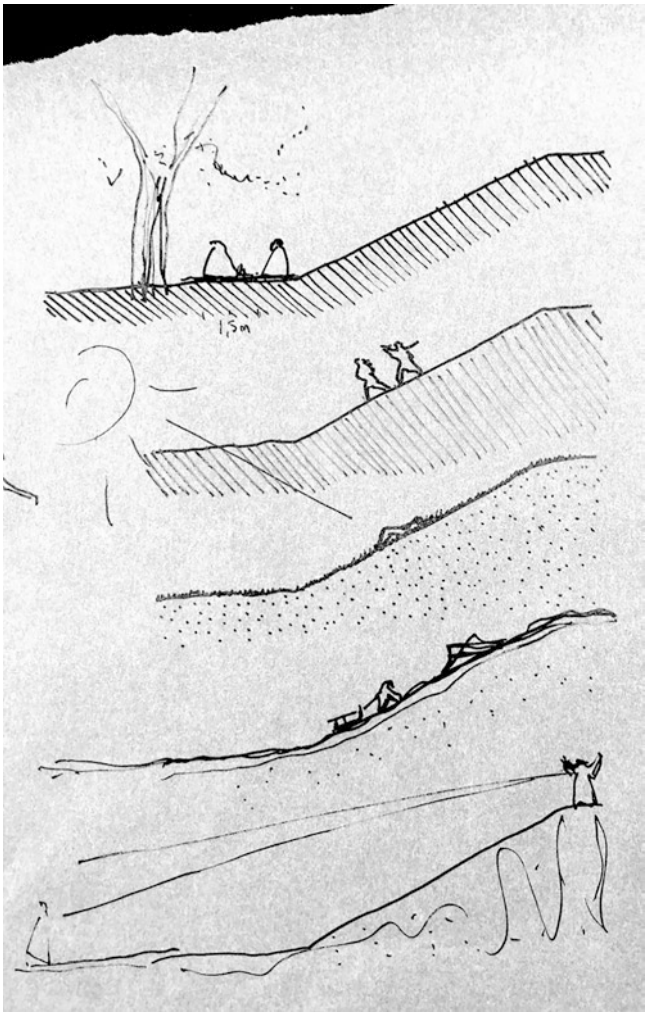

Fig. 5.2 Five diagrammatic sections, slope of Aalborghus Slotspark. (figure by Ditte Bendix Lanng, 2019)

- It affords a playful, unrestrained run downwards
- It affords cloud watching on the soft grass
- It affords a struggling bodily effort to get to the top – perhaps pulling the sled up on slippery snow;
- It affords a privileged position from which to see and be seen

With these affordances, the urban slope is an intriguing example. Daily life human actions and experiences are made possible here—actions and experiences with basic qualities of inhabiting the city. The form of the slope is simple—a distinct modeling of an urban floor. It is a human-made sculpted *folding* in the crust of the earth that—by that very folding—affords numerous actions and experiences. The folding multiplies the possibilities for intimate bodily interactions with the urban floor.

The exemplified affordances of the urban slope are specific to the slope of this park. A wealth of specificities—material features, details, and contextual characteristics—are relevant to understand what the urban slope affords. We can make this point vivid by asking how affordances would be different if various features of the slope were changed: What if, for example, the slope was not covered with grass, affording a certain kind of tactile relationship with the body, but instead had a concrete surface? What if it was clad in wood? What if it was not a smooth inclination as this one, but was modified to have steps carved into it, or raised platforms added to it? What if the inclination was altered, so that the slope would be steeper? What if, instead of the location of the slope in this shielded, enclosed urban space in the inner city, it was located on a windy site by the fiord only a stone's throw to the north?

These, and other alterations of the design features of the slope, would change the affordances of it. This speaks to the importance of both form-making and of contextual sensitivity. And it speaks to how affordance lets us regard the small scale of the design of the city. Very specifically and with detail, it sharpens the urban designer's apprehension of humans being-in space. This apprehension can shape an alternative to a visual or structural city making method, in cultivating attention to possible relations between humans and their environment, shaped around the "many nitty-gritty, material-performative details that are so important to both architects' design and users' experiences" and through that "evade perhaps all (visual) symbolism" (Kraftl & Adey, 2008, p. 214). In other words, this apprehension of humans being-in space zooms in on how urban design may work to "kindle certain capacities for inhabitation" (ibid., p. 225), in producing affordances for human action and experience.

5.4 Atmosphere

According to Heft (2010), affordance connects not only to potential human activity, but it also connects to the affective quality or emotional intensity of a possibility in the physical environment (see also Jensen et al., 2017). Through the example above, we might be able to imagine ourselves in the position of the human on the slope who

has decided to lay down and enjoy a moment of *cloud watching on the soft grass.* This is not just an instrumental action-oriented situation. Rather it is a situation charged with an *affective pull* (Heft, 2010), in which multiple senses and emotions may be activated: the tactile feeling of the soft grass, its smell; the sun warming the body, the occasional clouds changing the visual scene above you.

We may attempt to understand this through the notion of *atmosphere*. Despite its ephemeral status, there seems to be an acknowledgment of the condition that humans are deeply intertwined with the atmospheres of urban spaces. Philosopher Gernot Böhme argued that atmosphere "does not relate to the determinations of things, but to the way in which they radiate outwards into space, to their output as generators of atmospheres" (Böhme, 2013, p. 14). Such a notion of *radiation* suggests that the atmospheres of an urban space is coming into being in the interactions between humans and the many other components of the space. Here these include the full situation, made up by the form, orientation, material of the slope, the weather, time of day, the contextual location of the slope and the park, and much more. This underlines that the affordances of an urban space have to do with much more than the *actions* it affords; that it is deeply connected to the *experiences* (including sensorial impressions and emotions) that it affords. The relationship between affordance and atmosphere has to do with the embodied sensations of given materialities, as well as with the *cultural readings* of the situation. Atmospheres entangle affordances through a complex relationship between physical actions, multisensorial sensations, and cultural conventions.

5.5 Beyond Manual

The relationality of affordances makes it clear that designers cannot prescribe (all) actions and experiences. Humans tend to approximate urban spaces, use them, and experience them, on their own terms. So, rather than applying affordance as a tool to strive for an exact prescription of activities and experiences, we may consider how designed urban spaces offer certain *suggestions* for inhabiting the city. The slope has certain *propensities* (or, suggestions) to invite certain actions and experiences, but it does not determine these (it is, in the words of Shield from the opening quote, causative, not causal). Above we foregrounded that affordances of urban environments are relational and situational, not universal. The material design interacts with, makes possible, or hinders certain types of inhabitations. Humans, on the other hand, go along with, ignore, or transgress the intended possibilities. In effect the designed environment may afford many different inhabitations beyond the intentions of the designer, as we saw it through the slope of the castle park.

The realization that designed urban environments work beyond the intentions of the designer should not, however, be considered a threat (Lanng & Borg, 2021). Architectural scholar David Leatherbarrow urges designers, instead, to cherish how architecture always exists in its "concrete reality […] regardless of my interests or yours" (Leatherbarrow, 2009, p. 46). He emphasizes that it is by means of

architecture's participation in the shared conditions of those concrete realities that prolific patterns of life occur (see also Till, 2009). This may be particularly relevant when considering urban space: open, publicly accessible, and forming part of the shared connective tissue of the city.

From some urban theories we learn that openness and even disorder have important value for the inhabitation of cities (Sandra & Sennett, 2020). City life cannot be put on manual. Contrary to what a determinist planning philosophy suggests, spaces of openness and unruliness may become spaces for human flourishing (this may be considered through the notion of *loose spaces*, see Franck & Stevens, 2007). Philosopher Michael Waltzer directs our attention to the need for "open-minded" spaces in the light of an increasing amount of "single-minded" space design (Waltzer, 1986). While the latter may be important for particular urban functions such as commerce, the city must offer spaces free from dictate and instruction: open-minded spaces that can lead to unplanned vitality and diverse interaction. Sociologist Richard Sennett argued that when conflict is permitted in the public sphere, the result will be "greater sensitivity in public life" (Sennett, 1996, p. 198).

For the usage of affordance as an urban design tool, this suggests an acknowledgment of openness and the absence of designed instructions. The design of public urban space must find the delicate balance of offering possibilities but maintain an openness for human *actualization* and approximation. Honing in on the affordances of an urban space can allow the urban designer a trajectory to work through the concrete realities of the ways in which humans inhabit space, and how urban space design aid in providing such balanced opportunities for inhabitation.

5.6 Conclusion

With this essay, we have examined the proposition that affordance can serve as an operational tool in a human-oriented urban design methodology. By applying the concept of affordance as a tool for elaborating the relational quality of the urban park above, we have engaged in an attunement to the inhabitation of that urban landscape. The concept of affordance foregrounds a detailed awareness of the possibilities for actions and experiences that are made possible by this particular urban landscape. In this sense, affordance performs as an operational tool for urban design analysis and development. It equips the urban designer with a qualified and reflective inception for a design approach that centers on precise considerations of human being-in space, herein with the small scale of forming material propensities to invite activities and multisensorial engagements in urban space.

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Chapter 6
Anthropological Affordances

Tim Ingold

6.1 The Ecological Approach in Anthropology and Psychology

I come from a background in ecological anthropology, a specialism dedicated to understanding how human beings adapt to their environments through the mediation of ways of doing things that are not just innate but, to an extent probably unmatched in the animal kingdom, culturally learned. Our efforts, however, had run into an impasse. For we could not decide where to place culture in the human–environment relation. Is the environment a natural given: a set of objective conditions to which its human inhabitants devise adaptive solutions, drawing on the resources of culture to do so? Or does the world become an environment for humans only insofar as it is already invested by culture with meanings and values, which then condition the practices in which they engage? Or to put it another way, does nature set the terms of adaptation, to which human populations respond by means of culture, or is it culture that actually sets the terms? This, of course, is an old debate, pitting physical determinism against cultural constructionism.[1] But as I was searching for a way to resolve it, a possible answer came from an unexpected quarter, namely the ecological approach to perception and action pioneered in the field of psychology by James Gibson.

[1] Perhaps the most famous articulation of the anthropological debate was by Marshall Sahlins, in his *Culture and Practical Reason* (Sahlins, 1976). Sahlins took the side of culture.

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This was in the early 1980s. At that time, Gibson's work was virtually unknown in anthropology. I have found only one previous reference to it in anthropological literature, in an essay on "Cultural factors in spatial orientation," penned in the 1950s by A. Irving Hallowell (1955: 184–202). One of the most prescient and original anthropologists of his day, Hallowell already sensed that Gibson's ideas could help us ground cultural variation in immediate perceptual experience. But he was so far ahead of his time that his proposals fell on deaf ears and were not followed up. Knowing nothing of this, I was introduced to ecological psychology from quite another quarter. I had recently published an article (Ingold, 1983) addressing the problem of where to locate culture in the human–environment equation and had concluded that while human beings can draw on adaptive resources of both natural and cultural provenance, in varying proportions, the purpose that drives their activity, and gives meaning and value to what they do, is inherently *social*. It is therefore essential, I insisted, to distinguish between the domain of social relations, as the crucible of agency, from the domain of nature-culture, which furnishes the instruments that allow this agency to be carried through into practice.

By good fortune, Ed Reed, one of Gibson's most brilliant but tragically short-lived disciples, came across my article and took the trouble to write to me.[2] In his letter, he pointed out that what I had said about the instrumental role of natural and cultural resources could be better expressed with the Gibsonian concept of affordance. For the human being at large in an environment, I would only have to say that the things encountered there, whether naturally present or culturally formed, afford openings along which social life can proceed, or alternatively, hindrances that block the way. Intrigued by this suggestion, I delved into the literature of ecological psychology and began attending the international conferences on "event perception and action," which brought its practitioners together. All were united in their opposition to the premise, fundamental to mainstream cognitive psychology, that perception is the operation of a mind, encased in a body, in processing the data of raw sensation into final images or "percepts." They would insist, to the contrary, that perception is the achievement of a whole living organism, indissolubly mind and body, actively engaged in its surroundings. As such, perception yields to no finalities, but *carries on*, even as life does. Or as Gibson (1979: 253) put it, "perception … does not have an end. Perceiving goes on."

Nevertheless, despite their common allegiance to a Gibsonian program, I found ecological psychologists to be fiercely divided among themselves. The seeds of discord had indeed already been sown in Gibson's seminal text, *The Ecological Approach to Visual Perception*, in which he had simultaneously put forward two, apparently irreconcilable positions. One, which we could call "realist," is that objects in the environment afford what they do because of what they are. Affordances, that is, are intrinsic properties of objects in themselves, regardless of whether any living being is there to realize them. They define a niche in the environment for a creature to fill; remove the creature, and the niche is still there. The other position,

[2] Reed's (1988) study, *James J. Gibson and the Psychology of Perception*, remains definitive.

which we could call "relational," is that affordances exist only insofar as they are realized in the activity of a creature for which, or for whom, they are of consequence. No creature; no affordance. Wanting it both ways, Gibson insisted that affordances are real, objective, and physical, even as they are properties of an environment that—in explicit *contrast* to the physical world—is constituted only in relation to the being whose environment it is.[3] For me, this discord immediately rang a bell. Not only did it echo contradictions in my own thinking; it also pointed a way toward their resolution.

6.2 What to Do About Culture

For as I now realize, I too had been trying to have it both ways, taking a realist stance with regard to matters of nature and culture, or objects and artifacts, but a relational stance with regard to the conduct of social life. In effect, I had divided the human being into two: the *person*, constituted as an agentive subject by way of their involvement with others in an ever-unfolding field of social relations; and the *organism*, adapting to a given environment through a suite of innate and acquired attributes. It was a position that could be upheld only by cutting out the domain of the social from the ecological domain of organism–environment interaction, and assigning to each a distinct ontological status. But as the tension between the two ontologies became unsustainable, it dawned on me that the human being is not dual but singular—that being an organism and being a person are one and the same. I would have, then, to extend the kind of relational thinking I had applied to human persons beyond their association with one another to include everything else that, at one time or another, would figure in their lives. What we had been used to calling social relations would thus be but a subfield of the wider field of environmental relations.

My first attempt to think this through was published in 1992, in a paper entitled "Culture and the perception of the environment" (Ingold, 1992). Pitching my argument against both the constructionist view that culture provides a template for organizing the chaos of bodily sensation into meaningful representations and the adaptationist view that it endows its possessors with the knowledge and equipment they need to function in the material world, I suggested that a relational approach to affordances might give us a language in which to express how people continually bring forth environments, and environments people, that could escape the endless back and forth between nature and culture within which ecological anthropology had become trapped. In the language of affordances, people would be differentiated not by culture but by their variable attunement, through practiced skills of perception and action, to the features of a world that are ever brought forth into presence

[3] Spot the difference between this: "No animal could exist without an environment surrounding it. Equally … an environment implies an animal (or at least an organism) to be surrounded" (1979: 8), and this: "The organism depends on the environment for its life, but the environment does not depend on the organism for its existence" (1979: 129).

by way of their own activity. If nonhuman beings can enter into meaningful relations with the world without these relations having to be mediated by the concepts and categories of a cultural tradition, then, I argued, this must equally be true of humans. Culture, in short, doesn't get in between people and their environments. Nothing is between.

Indeed, somewhat overstating the case, I proposed that the best way to deal with the problem of what to do about culture is simply to eliminate it from the ecological equation, or to accord it at best a secondary role as a medium not of perception but of interpretation. We perceive as we go along; we interpret when, reflexively, we look back on what we and others have done, recalling it in memory, narrating it in stories, and evaluating it in judgments. Perhaps it is in their interpretative prowess, made possible by faculties of language and symbolism, that human beings, compared to other animals, truly come into their own. This, in turn, offered a solution to another longstanding anthropological conundrum. It lies in the problem of how we can come into a shared perception of the world, with people whose experiences of life have heretofore been very different from ours. Classically, understanding the people of another culture was regarded as a task of translation: an attempt to establish a cross-over between distinct conceptual worlds. To see things as other people do meant keying into their concepts. Yet how can you do this when, without having already understood the concepts, it is impossible to obtain the key? You would be caught in a vicious circle.

Returning to this problem, a year after my initial foray into Gibson's ecological approach to perception, the theory of affordances once again pointed toward an answer (Ingold, 1993). For if perception is not about organizing sensory data in terms of acquired concepts, but rather attends to what the world itself affords in the practical conduct of life, then to perceive the world as others do, we don't have to get inside their heads. It is enough to join with them in their activities. All perception entails movement, and as Gibson (1979: 200) pointed out, since moving observers can be in the same place at different times, it requires no effort of conceptualization for them to share the same world. Perception, in other words, is carried on in public, rather than in the privacy of isolated minds. It requires only that we should participate with others, attend closely and carefully to what they are doing, and attune our movements with theirs. By doing so—that is, by practicing the method that anthropologists call "participant observation"—we bring forth an environment of affordances in common. This commonality lies, if you will, on the hither side of concepts: it precedes and facilitates, rather than depends upon, representation and interpretation. It is this, of course, that makes anthropological fieldwork possible.

6.3 Affordance and Interpretation

In hindsight, however, I had perhaps been overhasty in expelling culture from the field of human–environment relations. My objection was not, after all, to the idea of culture as such, but to its association, in the anthropological canon, with a certain

way of thinking about difference. It is a way that imagines a world divided between people of our own and other cultures, each locked into its particular frame of concepts and categories, or "worldview," for organizing the data of experience. The theory of affordances, by contrast, leads us to see difference as emergent from within the nexus of our practical involvement with beings and things in the world around us, and in the variable skills of perception and action to which it gives rise. Thus if two companions, going along together, perceive things differently, it is not because they are bringing different mindsets to bear in organizing the same corpus of sensory data, but because they have been differentially attuned, through prior experience, to what the environment affords. And if culture is just another word for difference, of a kind that is not laid down in advance but develops in the course of the human life-cycle, then it is not unreasonable to regard the differences we have been used to calling cultural as variations on the theme of skill.[4]

Yet for all that, the idea that in perception, life enters into a direct and unmediated relation with the world, even as the world opens up to its living inhabitants, has proved hard for many anthropologists to swallow. It is almost an article of faith, in anthropology, that things can never be perceived directly, but only by way of other things that stand for them. Or in a word, we perceive only *signs* of things, not things themselves. There can be no meaning, in this view, without signification. Anthropology always wants to hide presence behind its representative signs, perception behind interpretation. The perspective of affordances, however, puts this into reverse. It asserts that we perceive things as they come forward into immediate presence and impinge on our activity, and not only by way of the signs they leave in their wake. Interpretation comes later. This idea of direct perception, however, has been widely misunderstood. It doesn't mean that the world simply imprints itself on the mind like a foot in mud, to leave an indelible impression, or that there is some kind of mystical fusion between a being and its world. Rather, in Gibson's understanding, perception takes work: it is the investigative peering, snooping, sniffing, rummaging, and fumbling that goes on as perceivers discover, in practice, what things afford.

This, ultimately, is what sets the ecological approach to perception apart from an alternative that has gained much greater traction in recent anthropology. The source of this latter approach lies in the semiotics of Charles Sanders Peirce. For Peirce, perception is all about signs and their interpretation. Everything one might perceive—be it a trace, a likeness, a word[5]—is a sign of something else, yet what it stands for turns out to be a sign for something else again, and so on in an unending chain of signification in which the world seems to escape, like the end of the rainbow, as fast as the perceiver catches up with it. All life, in this view, is semiosis, a

[4] This argument is developed at length in several of the constituent essays of my book *The Perception of the Environment* (Ingold, 2000).

[5] These correspond to the three kinds of signs, respectively indexical, iconic, and symbolic, which Peirce identified in his inquiry.

tracking of signs and their meanings.[6] At first glance, this Peircean understanding of perception has much in common with Gibson's. There is the same pragmatic focus on actor-perceivers, at large in an environment, finding a way through, by sussing out the meanings of the things they encounter. But here's the difference: for Gibson, meanings are affordances, not interpretations; and affordances are ways along which the world comes into presence, not the residual traces or indications of a world that has already vanished into absence or hidden from plain sight. Affordances are directly perceived, not represented or interpreted.

But anthropologists, convinced that meaning requires signs, have been more concerned with extending sign processes to nonhuman worlds than considering the possibility that the perception of affordances, common to nonhuman animals, might work just as well for humans. In a recent example of the genre, an anthropological study among the Runa people of Ecuador, Eduardo Kohn elaborates a complex semiotic theory of environmental perception without once mentioning the idea of affordances or referring to the ecological approach (Kohn, 2013). It is in representing the world, Kohn insists, that animate life distinguishes itself from the residue of inanimate matter. Yet he is also convinced that signs connote the absence of that to which they refer: "all kinds of signs in some way or other re-present what is not present" (Kohn, 2013: 23). But how can a creature possibly remain alive if the real world continually escapes from it? All living organisms need to eat and breathe: but none can breathe absent air or eat absent food. These metabolic processes are fundamental to life. Indeed, if anything distinguishes life from non-life, it is not representation and interpretation but the coupling of action and perception. The challenge for the living organism is not to represent the world in its absence but to participate from within in the world's very coming into presence.

6.4 A World Without Objects

It is high time, I believe, to forge a vocabulary that will allow us to restore the world to presence. We cannot do so, however, without facing up to a deep-seated imbalance in Gibson's own approach to perception. For a while, on the one hand, he brings the perceiver back to life, as a being who is continually moving around, actively attending to things, exploring their inexhaustible potentials, and becoming ever more skilled in the process; on the other hand, the environment is effectively solidified: it is portrayed as an environment of *objects*, every one of which is fixed in a rigid and invariant form, rendered inert, ready and waiting for the perceiver to come on the scene and to discover what it affords. That's why, after having long considered myself an advocate of the theory of affordances, I have latterly become a critic. For perception, as I would now understand it, is not just a matter of

[6] In his last collection of essays, semiotician Thomas Sebeok declared the "two cardinal and reciprocal axioms of semiotics" to be that "all life is semiosis," and that "semiosis presupposes life" (Sebeok, 2001: 10).

exploring a world of objects that are already there, or that have—so to speak—"precipitated out" from the formative processes that have given rise to them; it must also be about being present and aware in the very moment of formation itself. This is to join with a "world without objects," on the crest of its incipience (Ingold, 2015: 13–17).

There is a beautiful passage in *The Ecological Approach to Visual Perception* in which Gibson describes the make-up of the environment. It consists, he says, "of the earth and the sky with objects *on* the earth and *in* the sky, of mountains and clouds, fires and sunsets, pebbles and stars" (1979: 66). Do mountains, fires, and pebbles, then, rest upon the earth? Do clouds, sunsets, and stars hang in the sky? Gibson would have it so. He imagines an environment cluttered with objects, much like the room of a house is cluttered with furniture. This cluttering, he contends, renders it habitable (1979: 78). Just as removing all the furniture from the room leaves a bare floor, so a world without objects could only be a barren plain, absolutely flat, stretching in all directions to the circle of the horizon. Such, according to Gibson, is the ground. As the "reference surface for all other surfaces" (1979: 33), the ground provides a solid base upon which is mounted everything that might figure as an object of perception, barring those celestial bodies whose abode is in the sky. This applies, moreover, not only to the city, with its buildings and streets, but also to the countryside with its fields and forests, rocky outcrops and pebble-strewn streams.

Gibson's default assumption, in a word, is that the terrestrial environment is *built*. It is as if we were presented not with the world itself but with its full-scale reconstruction, all laid out in advance. But the real world is not like that. Mountains, for example, do not stand erect upon the ground but are formations of the ground itself, continually shaped as the earth's rising, driven by tectonic forces, meets the sky's falling in the erosive effects of wind and weather. In this world, unlike in its reconstruction, fires burn and pebbles grate; clouds billow as moisture-laden folds of crumpled air and glow in the light of the setting sun; stars shine as pin-pricks of light in the night sky. All are phenomena of an environment that is not already built—already populated with objects—but ever in formation. Even in the city, buildings do not really stand upon the surface of the earth but are sunk into it, in their foundations, while above ground they contend with the atmospheric elements. Like trees, with their roots, branches, and canopies, buildings are no more *on* the earth than they are *in* the sky; they are rather simultaneously earthly and celestial. Indeed, it is only because they are *of* the earth that they are also *of* the sky (Ingold, 2022: 157).

A habitable ground, then, is not a hard surface furnished with objects, as Gibson thought. It is rather a surface that is soft and permeable, allowing the elements of earth, air, and moisture, powered by the fire of the sun, to mix and mingle, creating thereby the conditions for living things to flourish (Ingold, 2011: 120–1). The primary condition of life is not solidity but flux. And for perceivers, immersed in the flux, the world is evidently not always ready and waiting. They have also to be ready and waiting for the world, attending to it in the sense of abiding with it and doing its bidding. There are thus two sides to attention. One side—with which Gibson is primarily concerned—has to do with perceptual *attunement* to the affordances of

the environment. That's when the world waits for you. The other side, of your waiting for the world, is a matter of *exposure*. Literally, to be exposed means being pulled out of position.[7] In this displaced condition, the sense of understanding—of having solid ground beneath your feet—is shaken, leaving you vulnerable and hyper-alert, wide-eyed in astonishment rather than narrowly focused on a target. This is not so much an under*standing* as an under*going*, which strips away the veneer of certainty wherein we find comfort and security, and opens to pure possibility.

6.5 Between Anticipation and Perception

To rebalance the theory of perception, we have to give equal weight to the two sides of attention, of exposure and attunement, of waiting on a worlding world and tuning in to a world-in-waiting. What, then, is the relation between them? There's no doubt that to embark on any activity, be it to hunt and fish, to farm, to set sail, indeed to carry on almost any kind of livelihood on land or at sea, means putting one's existence on the line. The safe course would be to stay put. To live, however, we have to get moving, to push the boat out into the current of a world-in-formation. Thus, all undergoing begins in exposure. But as it proceeds, skills of perception and action, born of practice and experience, begin to kick in. When walking, for example, we place ourselves at risk with every step, falling forward on one foot, tumbling into the void, only to regain our poise, albeit temporarily, as the other foot comes to land on the ground ahead. What commences with the vulnerability of exposure ends in the mastery of attunement, providing in turn the ground from which the walker can once again submit to the hazard of exposure, in an alternation that continues for as long as the walk goes on.

This alternation, I believe, is fundamental to all life. But it is also unidirectional. That is to say, in real life, *submission leads and mastery follows*; never the reverse (Ingold, 2015: 38–42). Where submission casts off into a world in becoming, setting us loose to fall, mastery restores our grip so we can keep going. The first is a moment of *aspiration*; the second a moment of *prehension*. Out in front, an aspirant anticipation feels its way forward, improvising a passage, while bringing up the rear is a prehensile perception already accustomed to the ways of the world and skilled in attending and responding to its affordances. And as submission gives way to mastery, aspiration to prehension, anticipation to perception, and exposure to attunement, there comes a turning point at which a tentative opening matures into a firm sense of direction. The Ancient Greeks had a word for this, namely *kairos*, denoting not just the moment that must be seized but the attention and responsiveness

[7] From the Latin *ex-* ("out") plus *-positio* ("position"). "To open our eyes is to get a look at what is evident," writes philosopher of education Jan Masschelein; "it is, as I would like to say, about being or becoming attentive, it is to expose oneself" (Masschelein, 2010: 46).

necessary to do so.[8] It is the point when the archer, having bent his bow, releases the arrow toward its target, or when the weaver shoots the shuttle through the shed of the loom. The ability to catch this moment, and not to let it pass, is perhaps the greatest part of any craft skill.

In the foregoing, I have inserted two supplementary terms, namely "aspiration" and "anticipation." Both call for some explanation. Literally, to aspire is to draw breath. Like breathing in to breathe out, aspiration gathers up the past in order to cast it forward, along a line of attention. Brimming with as yet undirected potential, aspiration *anticipates* the future, but does not *predict* it. Far from predetermining the final forms of things, or fixing their ultimate destinations, anticipation opens up a path and improvises a passage.[9] It is, if you will, a seeing into the future rather than the projection of an end state in the present (Ingold, 2013: 69). Thus, where anticipation and aspiration lead (in exposure), perception and prehension follow (in attunement). Might this offer a possible solution to another question often put to me, to which the answer, up to now, has proved elusive? The question is: where, in our thinking about perception, can we find a place for "imagination"? For those of a cognitivist persuasion, of course, this is a non-problem. For them, the percept is an image, a representation, and as such on the other side of the fence from the reality it purports to represent. Thus, to perceive *is* to imagine. But what if, with Gibson, we suppose that perception opens directly to the real? What happens to imagination then?

Gibson (1979: 255–6) lists imagining as one of a number of forms of awareness that "are not strictly perceptual"; others include dreaming and wishful thinking. There is, he says, a simple test for telling the perceptual and the non-perceptual apart. Reality is inexhaustible; the more you subject it to scrutiny, the more you will discover. Not so, however, with the image. For try as you might, you will never find in it more than the mind has already placed there.[10] All you can do is add to it, by way of interpretation. Perceiving is to imagining, then, as discovery to interpretation (Ingold, 2022: 32). But do the real and the imaginary have to be thus split apart? Might they rather be unified at the very moment, in the alternation of life, when perception turns to anticipation, and prehension to aspiration? This is to think of imagination not as a power of mental representation, but as a way of living creatively in a world that is not already created, already formed, but is itself crescent, always running ahead of itself. In excess of the crescent world over the objects left in its wake, affordance gives way to pure possibility. To inhabit this world, in perception and imagination, is to participate from within in its self-making, its autopoiesis. And that, to my mind, is the calling of anthropology.

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[8] For a fuller discussion of *kairos*, see Hawhee (2004).

[9] According to philosopher Jacques Derrida, to anticipate is "to take the initiative, to be out in front, to take (*capere*) in advance (*ante*)" (Derrida, 1993: 4).

[10] In an essay first published in 1940, Jean-Paul Sartre had made an identical point: "No matter how long I may look at an image, I shall never find anything in it but what I put there." Herein, he continued, lies the essential difference between an image and a perception, for in the latter "there is always, at each and every moment. Infinitely *more* than we see" (Sartre, 1972: 7–8).

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Chapter 7
Affordances and Social Normativity: Steps Toward an Integrative View

Manuel Heras-Escribano

7.1 Introduction

Affordances are everywhere in our everyday lives. From walking to grasping a mug or opening a door, bodily action opportunities are pervasive. But if they are so common to find (maybe they are the most common object of perception), how is it that they were formulated only a few decades ago? This has to do with the development of ecological psychology, of which affordances are their main concept. Since their inception in the 1970s through this new approach to the mind, affordances have been applied to several fields of study, from architecture and design (Rietveld et al., 2015) to philosophy of mind (Chemero, 2009) and robotics (Gijón et al., 2013).

But for affordances to be proposed as an object of study, a new reformulation of perception and action was needed, and this is what ecological psychology is all about. Ecological psychology was created by James and Eleanor Gibson between the 1960s and the 1980s (Gibson, 1969, 1979). It was conceived as a reaction against both cognitivism and behaviorism: it rejected the idea of cognition as based on information-processing and representation-consuming mechanisms, but also the stimulus-response formula and the idea of perception as a passive reception of worldly impingements (Lobo et al., 2018). Ecological psychology was inspired by functionalist psychology and Jamesian pragmatism; hence, it considered that the starting point of the study of cognition was the organism–environment system, not the brain or the organism alone (Heft, 2001). The organism, an active explorer, engages with the environment thanks to ecological information, and this is why it perceives the available affordances. The idea of ecological information changes the traditional way of understanding perception (from a sensation-based account to an information-based account) and establishes the bedrock for an ecological method in experimental psychology (Richardson et al., 2008).

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One of the main aspects of debate for ecological psychology is the relation of affordances with human socionormative practices. Several authors inside and outside the ecological approach aimed to reconcile the original Gibsonian understanding of affordances, which is agent-centered, with the unavoidably social constitution of our cognitive capacities. James Gibson himself was aware of this, and even when he claimed that the cultural and the natural environments are the same one and that there are affordances with a social significance (Gibson, 1979), his death prevented him from developing these ideas. But some other authors continued this task of reuniting affordances and sociality. Paraphrasing Dewey, we are always immersed in a social environment: we are exposed to the evaluation of the members of our community, and we always receive some kind of social feedback from everything we individually do (Dewey, 1922/2007). If so, our way of dealing with affordances as individuals is also affected by this social dimension.

In this chapter, I offer the conceptual basis for establishing a comprehensive view of the entanglement of social norms and affordances from an ecological perspective. For this, I will focus on the connection among three key concepts: Costall's idea of canonical affordances, my own views on social normativity, and Reed's fields of promoted action. In Sect. 7.2, I will present the idea of canonical affordances. In Sect. 7.3, I will do the same with the idea of fields of promoted action. Section 7.4 will focus on my own views on social normativity and how norms are related to affordances. Finally, Sect. 7.5 will offer a general view of the connection among these three concepts in order to illuminate how the individual perception and taking of affordances are modulated by our social and normative practices.

7.2 Ecological Psychology, Direct Perception, and Canonical Affordances

Ecological psychology is based on three main ideas: first, organisms are not merely passive receptors of stimuli, but active explorers of their environments. Second, the main unit of analysis is not the organism per se, but the organism–environment system. And third, perception is mainly of affordances, which are directly perceived. Regarding the first claim, ecological psychology conceives organisms as agents that are always acting upon their environments, modifying them and extracting information that guides their action. Agents do not passively receive the impingements of the world: they navigate it and encounter it at all times. This shows the mutual affection between organism and environment: the organism affects the environment and the environment affects the organism, and if we adopt a diachronic perspective, we cannot fully understand organisms and their environments if we separate them. For this reason, ecological psychology does not focus on brains, nervous systems, or even organisms alone: this approach focuses on the unit or system formed by the organism and the environment. And this leads us to the third main claim: the direct perception of affordances.

Affordances are the main objects of perception for organisms according to ecological psychology. Affordances are peculiar objects of perception, as they are agent-related: mugs are perceived as graspable by humans (or apes) because of the combination of the cylindrical form of the mug itself and the ability to grasp of apes possess due to the opposable thumbs they have as part of their bodily equipment. This aspect of being *properties of objects related to bodily and action capacities* of organisms is what defines affordances. Another essential aspect that defines affordances is that they are *directly perceived*. This is because the way in which the perception of affordances is studied is not based on sensations (which has to be processed so as to form a representation in the brain and/or the mind), but on ecological information(Reed, 1991). This ecological information should not be confused with information in the Shannon-Weaver sense of the word, which also implies information processing. According to James Gibson, perception does not work that way. In the ecological view, information for perception does not need to be processed, disambiguated, or enriched to form a representation that replicates the environment (Turvey et al., 1981). On the contrary, ecological information is directly detected, and it is necessary and sufficient to perceive the environment as such—no representations or any other kinds of mediations are needed (Reed, 1996). Ecological information is the result of the energy arrays of the environment forming a heterogeneous pattern (due to reverberations in a given space) such that it reveals the surfaces of the environment and the available affordances (Glotzbach & Heft, 1982). Take, for example, a room in which a light bulb is shining: the light fills the medium (the air) with ambient light as rays of light reflect in the surfaces of the room, forming a structure that corresponds to the structure of the objects and surfaces of the room. The pattern is informative of the structure of the room itself. The organism encounters this informational structure, and this is enough for perceiving the room and its affordances directly from a given location or point of view. There is no need to postulate any kind of processing mechanism, representations, or any other kind of mediational entity or process for perceiving affordances (Chemero, 2009; Heras-Escribano, 2019).

Ecological information specifies the environment and its affordances because the informational pattern takes the structure of the environment, so the structure of the information corresponds to the structure of the environment. In this sense, the sole presence of ecological information is sufficient to perceive the available affordances. If there is a mug in the room and the organism that observes the room is one with opposable thumbs, ecological information specifies the possibility of grasping the affordance for that organism (Turvey, 2019).

As we can see, there is no need to appeal to either sensations or representations to explain how affordances are *directly perceived*. Unlike behaviorism, cognitivism, or enactivism, ecological psychology does not refer to sensations that need to be transformed or processed. It relies on information on the structure of the ambient optic array that reveals the shape of the environment that the organism is exploring. This is why the ambient optic array is informative about the environment: it is ecological information of the available affordances because that pattern or array is related to the bodily dimensions and abilities of the organisms that perceive the

environment. Perception is based on ecological information, not on sensations—and this is why it is directly detected.

We can see that affordances, being agent-related aspects of the environment, cut across the dichotomy between subjective and objective. However, according to Costall (1995), there is one dichotomy that Gibson could not overcome: the dichotomy of the natural and the sociocultural. This is because, according to Costall, Gibson aimed to explain perception as a universal trait of organisms, but he did not emphasize the fundamental contribution of sociality in the picture: he presented direct perception as essentially asocial (Costall, 1995: 474). Costall aimed to socialize affordances by including in the picture the essential social aspects that shape our cognition, which is the difference that humans make in nature (Costall, 1995: 478). One example of this is the introduction of the idea of canonical affordances as opposed to affordances in general. While affordances in general are available everywhere, canonical affordances are conventional and normative (Costall, 2012). This is why canonical affordances, according to Costall, are so tightly related to artifacts: technological objects are designed so as to facilitate one particular affordance, and this *facilitation* is shaped by our own sociocultural norms. For example, chairs are specifically designed to be sat on, and although they can afford some other actions (throwing them, for example), they are perceived as sit-on-able objects because our sociocultural background emphasizes that use. Just like we predefine the use of a technological artifact, we also predefine its affordances; or better: it is because we predefine in a normative way the affordances that a technological object has that we define the technological object per se. As Costall claimed: "The concept of *canonical affordances* itself alerts us to those important cases where the affordances of something are not simply shared between people but also normatively predefined" (Costall, 2012: 91). Normative predefinition has a major distinctive prescriptive force than merely sharing something: while sharedness could imply the random establishment of a convention (think of, for example, the way in which humans randomly create walkways or tracks that are followed spontaneously until they become part of the landscape), the normative predefinition implies a well-thought, deliberate previous step of thinking of the design of the artifact so as to optimize its usability—and this implies a designer that has considered what affordances they wish to make salient, hence the idea that some technological objects or devices have a function that is shown via their affordances. This is shown through the claim that "[a] theoretical understanding of *canonical affordances* will not be achieved by fixation upon the object in isolation, nor the individual-object dyad. The object needs to be understood within a network of relations not only among different people, but also a *constellation* of other objects drawn into a shared practice" (Costall, 2012: 92). The canon of canonical affordances is deliberate and socially shaped: not in the sense that all affordances are social, but in the sense in which sociality is part of reality—having a role that is as important as ecological information (Costall, 1995: 478). In this sense, "[c]anonical affordances still imply us, but in the plurality rather than the singular" (Costall & Richards, 2013: 87), and this plurality is constituted by social norms.

The introduction of sociality within the picture of the direct perception of affordances raises several questions: how intricate is the connection between social norms and affordances? Are there canonical affordances beyond the case of technological artifacts or devices? If so, how are they established if it is not by design? These questions will be dealt with in the upcoming sections. In the next one, we will take a look at Reed's fields of promoted action.

7.3 Reed's Fields of Promoted Action

The philosopher E. S. Reed aimed to explore all the implications of ecological psychology to the philosophy of mind. For that, he took into account the importance of development, and the work of Eleanor Gibson was key for that field. She aimed to analyze psychological development from an ecological standpoint, and her contributions to the field were outstanding. Reed applied that developmental view to his philosophical writings, and the results were exceptional. Among all the contributions, for the purposes of this chapter, we can highlight the idea of fields of promoted action as a key aspect of any child's development. He defined the idea in the following way:

> The field of promoted action includes all the affordances made available to or emphasized for the child by other people and excludes those affordances forbidden to the child by other people. The field of promoted action also includes those different actions that are encouraged or even scaffolded for the infant at different times (e.g., aiding to help sit or stand). The field of promoted action is a powerful force in human development, but it cannot shape the infant except through the windows of these interactive frames (Reed, 1996: 130).

So, as we can see, fields of promoted action emerge during the interaction of the infant and the adult in interactive frames. Reed establishes different interactive frames: the primal one (0–3 months), in which facial expressions and gaze at another's face is key; the performatory frame (3–9 months), in which infants start to see themselves as agents and show appreciation for different surfaces, substances, and textures, which leads to free action and learning about affordances; and the true interaction frame (3–9 months), in which the infant's response to caregiver activity (gazes, movements, but also speech) is crucial, as "infants will come to shape their behavior according to local cultural proprieties, for these proprieties will define how effective their gazes, smiles, and vocalizations are at eliciting interaction" (Reed, 1996: 133). In this period, from 3 to 9 months, interaction becomes crucial for understanding the infant's behavior:

> In the period from 3 to 9 months, human infants are becoming complete interactors—ones who combine vocalization and bodily movements with face-to-face interaction. They are beginning to make their own choices as to whether or not to interact. They are starting to master the intricate art of turn taking, the first of the complex of reciprocities that are necessary for successful social interaction. They have become game players, who not only undergo affective surges but do so in a shared context, linking the phases of their actions with those of their caregivers (Reed, 1996: 135).

These interactive frames are crucial for shaping the basic agency of human beings in their development. These are the frames in which human nature becomes sensitive to sociality, hence including this aspect as an essential feature of our way of being agents in the world. According to Reed, it is in these interaction frames in which the fields of promoted action appear, and they are presented to the agent as social invitations or prohibitions (implicit or explicit) for taking particular affordances (among other things). In this sense, sociality systematizes the infants' taking of affordances by exerting social pressures for promoting the taking of some affordances and the prohibition of taking some others, all of this because of purely socio-normative reasons.

My proposal here is to expand Reed's idea of fields of promoted action beyond infancy. I think these fields of promoted action are clearly present not only during development, but also in our everyday lives. We humans are always learning until we die, and every agent is constantly learning how to engage in particular situations in a more efficient way; thus, we must recognize that our experience of fields of promoted action continues to evolve across our lifespan. For this, the agent makes use of both the responsiveness to affordances and the responsiveness to social norms. There is a triadic interaction (to use Reed's apt phrase) for making sense of human nature in its completitude. And the framework of fields of promoted action is very useful when it comes to understanding the interaction of norms and affordances. These fields of promoted action should be understood as the specific contexts of interaction in which social norms are exerting their pressure; agents aim to act in the right way and, for that purpose, they make use of the available affordances. We find these frameworks for triadic interaction full of affordances and fields of promoted action constantly, so it is important to analyze how social norms and affordances are entangled. But, for that purpose, it is important to offer a clear definition of social norms.

7.4 Social Norms

Social norms are pervasive in our everyday lives. There are several appeals to social normativity by philosophers of mind and social cognition, but there are only a few definitions of what these social norms are. I have tried in some previous writings to offer a systematic definition of social normativity in human nature starting from the work of some authors in the pragmatist and post-analytic traditions, such as Dewey, Ryle, or Wittgenstein (Heras-Escribano, 2019; Heras-Escribano & de Pinedo-García, 2018). Here I show the main aspects of this view on social normativity.[1]

[1] In previous writings I have also analyzed the difference between the normative and the nomological, where I stated that the title "normativity" should be restricted to a social phenomenon and that we should not confuse the peculiar aspects of social normativity with non-social aspects that, while labeled as normative as well, they refer to subpersonal lawful regularities. For a detailed discussion on the issue, see Heras-Escribano (2020a, b), Raja and Chemero (2020), and Mojica (2020).

First of all, it is worth distinguishing between being right and being successful. My point with this is that the success–failure distinction does not exhaust the right–wrong distinction: we apply the predicate "successful" when a goal is achieved, but we reserve the predicate "right" when a goal is achieved correctly. This means that, among all possible ways to succeed, there is one that is the right one. And the impact of this distinction for agency is key because in this picture an agent becomes aware of how he or she is acting: the agent acquires epistemic responsibility for his or her actions. This is because someone who does the right thing is normally aware of her way of doing things and also because she aims to act in that way. In this picture, normative practices are equated with rational or intelligent practices, as the agent willingly aims to do things right, acquiring that responsibility for her performance. This is something stressed by authors such as Ryle:

> The well-regulated clock keeps good time and the well-drilled circus seal performs its tricks flawlessly, yet we do not call them 'intelligent'. We reserve this title for the persons responsible for their performances. To be intelligent is not merely to satisfy criteria, but to apply them; to regulate one's actions and not merely to be well-regulated (Ryle, 1949/2009: 17).

So, when an organism is aiming to act in a right or correct way, this means that the organism is aware of a certain norm or procedure and aims to act accordingly, which means that the agent acquires certain responsibility in her performance via social attribution or expectancy (although it can be self-ascribed as well, but first you have to be part of a social environment for acquiring this capacity of self-ascribing oneself an epistemic responsibility regarding the following of social norms). This acquisition of epistemic responsibility for doing the right thing when following a rule implies that the agent is rational or intelligent. This attribution of intelligence should not be understood in the intellectualist way, i.e., the way in which agents follow norms as if they repeat an explicit general instruction in their heads, leaving aside the particularities of the surrounding situation. We are intelligent not because we repeat general maxims in our head and follow them blindly, but because we acquire responsibility for our performances and aim to act rightly, taking into account the particularities of our current situation. As Ryle (1949/2009: 41) claimed, "understanding is a part of knowing how," which means that understanding is highly practical, that we are situated and the exercise of our cognitive capacities is context-sensitive.

Regarding this point, I proposed the idea of *pertinence* as key for understanding how social normativity is situated and highly practical. Once we acknowledge that norm-following is always online or situated, then we realize that being sensitive to the particularities of the context is an essential aspect of human agency. Then, the triadic interaction of agents, norms, and affordances demands a specific notion for evaluating an agent's performance. This comes with the idea of pertinence: one action would be more or less pertinent depending on a combination of the aim or goal to be achieved, the layout of the environment, and the correctness of the action according to the rules being followed for achieving the goal. Thus, "pertinence" is a key notion for describing normative actions because of its usefulness to assess the adequacy of a particular action given the goal, the norms, and the constraints and

facilitations of the environment. We claim that an action is "pertinent" when such action fulfills its goal by applying the correctness criteria in a successful way, solving the problems offered by the specific particularities of the environment. This is why the pertinence of an action is always context-dependent.

In sum, all human actions are subjected to social scrutiny since the earliest stages of human cognitive development, and they never cease to be. As Dewey claimed, "[s]ome activity proceeds from a man; then it sets up reactions in the surroundings. Others approve, disapprove, protest, encourage, share and resist" (Dewey, 1922/2007: 16–7). Individual behavior is shaped by these social reactions, which means that, in general, individual habits are formed through these socionormative institutions that shape the individual's dispositions, and tendencies to act in a certain way (Dewey, 1922/2007: 58). As we can see, a systematized approach to the main features of social normativity allows us to understand the main details of this phenomenon. Social norms are present since the earliest stages of our cognitive development, and they shape our behavior in the form of pressures and encouragements that promote social conformism in individual behavior.

7.5 Integrating Social Norms, Canonical Affordances, and Fields of Promoted Action

How can we disentangle the intricacy of affordances and social norms in our everyday life? From a first-person point of view, the direct perception of affordances and the social pressures for norm-following happen at the same time, but we should understand how they interact. As I wrote before, several questions arise: Are there canonical affordances beyond the case of technological artifacts or devices? How do social norms affect our dealing with affordances? Do fields of promoted action make us "blind" to certain affordances?

Regarding the first question, I think that the expansion of fields of promoted action to our everyday lives can be useful for illuminating whether there are canonical affordances beyond technological devices. In this view, if fields of promoted action are present everywhere (because social norms and affordances share the same space from a first-person perspective), then it is possible to establish canonical uses of affordances via social pressures and beyond technological devices. Thus, the constant pressure or promotion of certain affordances exerted by particular sociocultural norms or conventions produces the establishment of a canon for taking one affordance instead of another. To illustrate this, we could imagine context-dependent cases in which politically oppressed people perceive the throwability of stones as more salient than some other affordances for defending themselves from a tyrannical government, or that thousands of years ago, in the same scenario, the same stones could have been regarded as a source for making fire but not as a weapon for a hunter-gatherer community. In these examples, the stones remain the same, but in each example a different affordance is prioritized, and this prioritization is clearly

socially shaped and socially established. In all cases, the behavioral output of an individual is subjected to social evaluations, which applies to the taking of affordances. So imagine, with this, that the above-mentioned hunter-gatherer population discovers the use of rocks for making fire, and that given the scarcity of rocks in their environment it is established that the use of rocks is restricted to making fire, so they cannot use them as weapons to be thrown. Also, we could imagine that, eventually, the following generations would not feel inclined to use rocks as weapons because such use is not promoted or even regulated by the community. In this sense, canonical affordances are established when the society knows how to do something correctly in the most efficient way: this sets up the scenario with prescriptive force in which the agent aims to do the right thing and learns how to do it efficiently with practice. In sum, social norms work as pressure mechanisms that urge or encourage us to take some affordances instead of others. This is useful to understand how canonical affordances are established: they are not established or determined due to particular aspects of the object itself, but because of the very social norms that need to be followed in particular contexts. This can be obvious in the case of technological objects, as they are designed to satisfy particular norms. However, what is canonical may change in different contexts and depending on human needs or conventions.

As we can see, with the expansion of fields of promoted action beyond infancy and development, we can claim that there are different fields of promoted action that depend on different socionormative contexts. These fields of promoted action are the product of a particular engagement between agents regarding a particular social norm or a set of social norms. In this sense, the time frame of a particular field of promoted action is shaped by a particular social norm that is being followed at a particular time, and since agents aim to follow that norm to fulfill a goal, agents exclusively pay attention in those contexts to the affordances that allow us to act in the right way. The aspect of attention is important: given that every task is goal-directed, the attention of the agent is directed toward what is important to satisfy the goal correctly. Thus, the norm itself pushes the agent toward paying attention to the affordances that are relevant to satisfy the goal correctly. Thus, agents not only learn to act normatively in a more efficient way making use of particular affordances, which establishes a particular canonical use of them, but also educate their attention to look for the suitable affordances that allow them to perform that action. It is important to emphasize that the object of perception, the affordance, is not modified by social norms: what social norms do is to modulate our focus of attention so that we pay attention to some affordances instead of others. In this sense, social norms exert pressure in the repertoire of exploratory patterns to make us focus on the affordances that are relevant for following the norm. The rest of the affordances become irrelevant; hence, agents are said to be "blind" to the affordances that are not relevant to the goal the agent is pursuing.

7.6 Conclusion

In this chapter, I aimed to begin disentangling the concepts of social norms and affordances. From a first-person perspective, our everyday experience provides us with different available social norms and affordances. They share the same space, and they are equally demanding. Even when they are different (social norms are conventional and affordances are perceptual), they are equally real to us, just like Costall claimed. I tried to illuminate some aspects of how both are related in our experience through the analysis of the connections among them with the idea of Reed's fields of promoted action. For this, I expanded fields of promoted action from infant development to everyday experience: I think this move is reasonable because humans are always trying to improve their performance and learning how to follow norms and take affordances more efficiently. The idea of fields of promoted action could serve to highlight how social norms act like pressures for taking some affordances in different normative contexts, establishing canonical uses of affordances depending on the situation and the norm to be followed, and then educating our attention toward some specific affordances instead of some others (the ones that are relevant for satisfying a norm correctly). It is only by analyzing in detail how affordances and norms coexist and mutually affect each other that we can integrate these concepts under a single explanatory framework that does justice to our everyday experience.[2]

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Part III
Architectural View

Chapter 8
What Gestures (Can We) Afford? On the Resourcefulness of Tectonics in Architecture and Engineering

Marie Frier Hvejsel

8.1 Toward a Viable Development of the Built Environment?

The position of the architect-engineer is a difficult spot. As voiced repeatedly since 1972, we build and demolish too much while the planet, plants, and animals are suffering, and many are still without worthy living conditions (Meadows et al., 1972). Inevitably we need to arrive at improved resourcefulness, understood as an inventive and just use of the scarce resources available. In the case of architecture, such resourcefulness implies an improved correspondence between the physical resources applied in the engineering of construction and the ability of this same construction to support and enrich sustainable everyday life practices by means of its spatial capacities. These are capacities that are signified by delicate *atmospheres* as stated by German philosopher Gernot Böhme (2006), with the potential to profoundly impact our physical and psychological well-being as stated in recent research into the neuroscientific implications of architecture (Djebbara et al., 2021). However, whereas significant advances are achieved in the engineering of tools for measuring the material emission of construction as such, architects struggle to describe and position the possible long-term value stemming from the potential of these spatial capacities to support and enrich sustainable everyday life practices related to these hard measures (Beim & Hvejsel, 2019). Outlining an ecological correspondence between animal and environment, the notion of *affordances* coined by American psychologist James J. Gibson in describing that which the environment "offers the animal" marks a critical direction in this matter (Gibson, 1986, p. 127). In approaching a translation of the notion of affordances into architecture, Gibson states that architects are aware of how a surface at knee height affords sitting

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Z. Djebbara (ed.), *Affordances in Everyday Life*,
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on it, and "a glass wall affords seeing through but not walking through," but he concludes that we "lack a theory of affordances to encompass them in a system" (Gibson, 1986, p. 137).

In my perception, one of the finest examples of such affordance in architecture can be found in the sweeping plywood wall in Swedish architect Erik Gunnar Asplund's Woodland Crematorium Waiting Room, from 1940. As the wall sweeps out in a soft curvature at knee height, it forms a kind and supportive, almost human *gesture*, affording a sitting place in the most difficult situations. I hypothesize that two complementary long-term trajectories toward improved resourcefulness of the built environment can be identified in such *gestures*. First, they hold the potential to support our commitment to care for and repair constructions instead of demolishing them, resulting in improved resourcefulness at an environment-economic scale (Andersen & Hvejsel, 2022). Second, they hold the potential to support our individual well-being and ability to share constructions collectively, resulting in improved resourcefulness at a socio-economic scale (Sántha et al., 2022). If so, the notion of *gesture* presents itself as a possible key concept in mobilizing the theory of *affordances* within architecture, by referring the spatial language of construction explicitly to human body language. However, encompassing this theory systematically into our practice, as called for by Gibson, does not only entail an exploration of the architectural question of what such *gestures* potentially afford in terms of spatial perception, accounted for in detail by German architect Angelika Jäkel (2013). Simultaneously, it necessitates navigating its dependence with the engineering question of what *gestures* we can actually afford with the resources available in the technical realization of construction. By posing the question, what *gestures* (can we) afford, this chapter uses tectonic theory in an attempt at formulating a method for critically linking and navigating the two concepts toward an improved resourcefulness of construction.

8.2 Unfolding the Tectonic Potentials of "Gesture"

With reference to the ecological and contextual task of the Greek *tekton* in bringing together esthetics and technique, seminal scholars such as American architects Eduard F. Sekler and Kenneth Frampton, and Danish architect Anne Beim, have reintroduced and developed the potential of tectonic theory as a critical entrance to contemporary architectural practice integral to the engineering of construction (Sekler, 1965; Frampton, 1995; Beim & Madsen, 2014). Hence, a direction to describe the task of the contemporary architect-engineer within a resourceful correspondence of place and everyday life facilitated by construction is implied within the notion of tectonics. Building upon this implication and seeking *principles* to exemplify and mobilize it, this chapter employs the notion of *gesture* as a lens through which to zoom in and describe the conditions for improving this correspondence.

Describing "the employment of bodily movements, attitudes, expression of countenance, etc., as a means of giving effect to oratory," the notion of *gesture* was recorded already in 1410 among the first 15% words to appear in the dictionary (Oxford English Dictionary, 2011). Notably, the notion of *gesture* has, as pointed out by Danish philosopher Niels Albertsen, been applied by Austrian philosopher Ludwig Wittgenstein in defining architecture (Albertsen, 2012). "Good architecture is recognized in its ability to express a thought. Making you want to answer with a gesture" (Wittgenstein, 1980/1931, p. 22), Wittgenstein observed in 1931, following up in 1942, by summarizing that "architecture is gesture. Not all appropriate movements of the human body are gestures. Just as every building is not architecture" (Wittgenstein, 1980/1942, p. 42). However, by employing the notion of *gesture* here, it is not the intention to embark upon a theoretical discussion of what architecture is or should be, rather, it is to help point to practical design directions for what architecture can and should do.[1] Hence, whereas the notion is widely used in architecture, exemplified by Italian architect Gennaro Postiglione, designer Eleonora Lupo (Postiglione & Lupo, 2007) as well as Jäkel (2013), the focus here is to discuss the methodological potentials of *gesture*, toward building critical theory for practice in the necessary, tectonic integration of human and material resources discussed above.

8.3 What 'Gestures' Afford?

By transferring the notion of *gesture*, referring to human body language, onto the spatial language of architecture as suggested in this chapter, a potential to clarify the responsibility and field of action of the architect related to that of envisioning and prioritizing the possible affordances of construction can be observed. As stated by Gibson, an affordance of the environment "that is commensurate with the body of the observer himself is more easily picked up than one that is not commensurate with his body" (Gibson, 1986, p. 143). In this regard, *gesture* presents itself as a critical means for the architect, entailing a constant reminder of this commensurateness with the human body; *gesture* represents a potential to insist upon an understanding of architecture as a verb, as called for by American-Italian architect Sarah Robinson (2021), as the notion places the purposefulness of architecture explicitly outside the work itself. Entailing an embodiment, so to speak, of Robinson's account for the potential of architecture as a verb, *gesture* also entails a materialization of the necessary discussion of what architecture attempts to do, or *afford* if following Gibson, by means of its spatial capacities. Part language, part form, *gesture* is readily identifiable as the materialization of an intentional expression by the architect, as

[1] In this matter, the essay is part of a trajectory of research within the field of tectonics in architecture, exploring the methodological potentials of gesture, toward improving the resourcefulness of the built environment (Andersen & Hvejsel, 2022; Beim & Hvejsel, 2019; Hvejsel, 2011, 2018; Sántha et al., 2022).

in the case of Asplund's sweeping plywood wall. And when analyzed as *gesture*, as outlined in Hvejsel (2011, pp. 74–123) and Jäkel (2013, pp. 257–263), we discover that the practice of *sitting* as such does not suffice in stating the affordances resulting from Asplund's expression. The compassion and care for the individual contained within the *gesture* hereby become a social relief, also for mourners collectively, as they are sustained bodily toward mutual support. In this way, the *gesture* unfolds a physical potential to reduce the material resources spent in construction by expanding the perception of confined spaces and inviting us toward improved ways of sharing constructions without feeling squeezed. Finally, we are motivated to care for and repair constructions that have grown meaningful to us because of their resourcefulness, related to our actual needs across generations (Andersen & Hvejsel, 2022). Thus, rather than mere practicalities such as *sitting*, *gestures* like Asplund's voice an opportunity to collect evidence for how the spatial capacities of architecture can support and enrich sustainable, everyday life practices exactly by materializing the ability of architecture to move us beyond practicality. In this way, *gesture* outlines a direction toward critical application of the body of knowledge comprising architectural theory in practice by enabling a physical reference to the *atmospheres*, which signify the phenomenological correspondence between us and the built, intentional expressions voiced physically through construction (Böhme, 2006; Norberg-Schulz, 1985; Pallasmaa, 1996). As it is rather the compassion, kindness, and support expressed in Asplund's *gesture* that is primary and active in eventually affording *sitting* and hereby the relief of rest, *gesture* herein implies a potential by the architect to clearly communicate the delicate, *atmospheric* potentials of architecture beyond our field-specific knowledge. Kind and supportive *gestures* like Asplund's are thus likely to hold critical, long-term potentials toward motivating sustainable, everyday life practices at a socio-economic, as well as an environment-economic scale, by asking of us to improve our compassion as well as our abilities in care, repair, and sharing of the constructions that make up the built environment (Andersen & Hvejsel, 2022). However, as discussed in Sántha et al. (2022), the short-term economic focus on construction costs, and the quest to decrease emission measures in this process, often tend to dominate the decisions made in architectural practice, making it difficult for the architect to render probable the resourceful, long-term perspectives of *gestures* like Asplund's. Thus, while expanding upon what *gestures* afford, we simultaneously need to raise the question:

8.4 What "Gestures" Can We Afford?

If we read further into the dictionary description, it appears that the meaning of *gesture* is twofold, capturing the meanings: "a move or course of action undertaken as an expression of feeling" and the form of a desired "response from another" (Oxford English Dictionary, 2011). This dual meaning of *gesture* is of significance when it comes to the tectonic challenge of arriving at a resourceful correspondence between human and material resources in construction—between the architectural

imagination of spatial *gestures* and the engineering of technical *principles* supporting them. Symptomatically, Austrian-American architect Eduard F. Sekler employed the notion of *gesture* in distinguishing tectonics from structure, and the practice of construction as such, in his seminal essay *Structure, Construction, Tectonics* from 1965. Sekler did so by describing the task of the architect as that of tectonically expressing a "noble gesture which makes visible a play of forces, of load and support in column and entablature, calling forth our empathetic participation in the experience" (Sekler, 1965, p. 92). In relating Sekler's account of the tectonic to the dictionary description of *gesture*, we observe a parallel in which the spatial capacities of construction cannot be described independently of the technical, engineering *principles* employed in its realization (Hvejsel, 2018). In the case of Asplund's *gesture*, the resourceful application of the bending *principle* is inherent in the structural capacities of plywood. In this way, Sekler aligns with Wittgenstein's association of the *gesture* with architecture, in the sense that, to Sekler, *gesture* also distinguishes the engineering of architecture from mere construction "through tectonics" (Sekler, 1965, p. 92). With this expression, Sekler implies a responsibility of the engineer toward artistically communicating realities, hereby tying the *gesture* directly to the question of what and how our constructions afford. Hence, if continuing Sekler's line of thinking, a reverse approach to Gibson's notion of affordance as "that which the environment offers the animal" (Gibson, 1986, p. 127) is suggested, requiring the architect-engineer to simultaneously account for that which the animal offers the environment. Read in this way, we understand that it is Asplund's ethical awareness of the reality of the environmental purpose of the crematorium that eventually renders its *gestures* durable as a construction over time. As stated by Bengt O. H. Johansson in his analysis of the Woodland Cemetery, it "turns the mourners' attention toward nature, in order thus to dissolve their grief and be reconciled to it. Although the words were not in use at the time, the great circle of life is what it is all about" (Johansson, 1996, p. 108). Hence, in addressing the question: "what *gestures* can we afford?" tectonic theory implies a direction for grasping the reality of the ecological load that construction must support as a place-making *gesture* to reconcile human and material resources through construction. If recalling the intertwined social, economic, and environmental challenges currently facing the development of the built environment, this long-term responsibility of place is a load that must be accounted for in relation to the immediate costs and emissions affiliated with construction as such. Italian philosopher Giorgio Agamben's affiliation of *gesture* with wider ethical considerations is central in this regard, as he recalls the significance of *gesture* as a measure of our cultural credibility and social competencies. In this matter, Agamben states that the characteristics of *gesture* are "that in it there is neither production nor enactment, but undertaking and supporting" (Agamben, 2000/1991, p. 140), hereby committing our *gestures* to an ongoing analysis of the reality of what we need and can afford, given the scarcity of resources that we have available.

8.5 Perspectives of "Gesture" for Integrated Architecture and Engineering Research, Education, and Practice

If summarizing, *gestures* like Asplund's, whether realized inside or outside, unfold small-scale yet real-life laboratories through which to exchange and grow knowledge toward gradual improvement of the *affordances* of the built environment. Being open to interpretation across disciplines beyond architecture and engineering, as well as culture, age, gender, and levels of experience related to the built environment, while simultaneously being measurable as built realities of a certain environmental and economic cost, they mark a critical methodological potential for integrated architecture and engineering across research, education, and practice. Hence, as interdisciplinary laboratories, the concept of *gestures* opens a potential to study whether and how critical and aware spatial intentions communicated through architectural construction are responded to by users, in the form of lived *gestures* in their experience and behavior, and at what environmental and economic expense (Sántha et al., 2022). In this way, subtle yet critical *gesture*s like Asplund's ultimately offer a focused and systematic entry to studies of the wider ethical implications of this behavior, related to the improvement of the resourcefulness of the built environment in general.

In my work, I experience optimistically how developing architect-engineers are capable of systematically formulating and constructing *gestures*, creating a space of action for architecture to respond to and act upon wider ethical implications. In this regard, Fig. 8.1 exemplifies how such *gestures* can be active in empowering people to gain a foothold on the edge. The project illustrates the critical choice by the students to transform an abandoned water reservoir in Paris into transitional housing for the homeless, joined through long-term perspectives for active participation in communal activities and facilities such as a community kitchen, a library, and performing arts workshops, commenced simultaneously with the hosting of the 2024 Olympics' cultural program. When you are without a physical home, your home is the friend you hang out with on the street, as the students found in their analysis; therefore, the transitional housing is designed to *gesture* pairs and groups. In Fig. 8.2, the students have developed the *principles* to transform a housing block, otherwise destined for demolition, without the inhabitants needing to move. On the contrary, they are empowered to take part in the construction process, their first job becoming the dignifying *gesture* to participate in the transformation of their dwelling in accordance with everyday practices and needs. This *socio-tectonic* process is made possible by the in-depth knowledge acquired by the students about the existing construction *principles* and their potential resources for future *gestures*, such as in the transformation of a left-over shaft into a unique and dignifying bath.

In conclusion, this chapter argues that when understood as being tectonically integral to the engineered reality of construction, *gesture* presents itself as a key concept in mobilizing the theory of *affordances* as a critical method toward improved resourcefulness in the built environment. At a conceptual and analytical level,

Fig. 8.1 "*New Parisian Stories—A social outlook on cultural architecture*," Master's Thesis 2019 by Neematullah Siraj Azizullah, Sebastian Siggaard, and Thomas Røn Jensen, Supervisors: Marie Frier Hvejsel and Lars Damkilde

Fig. 8.2 **"***Neighbourhood—A tectonic elevation of A7*," Master's Thesis 2020 by Nikolaj Weberg Rahbek, Trygve Schmidt Pedersen, Jacob Fredsgaard Thams, Supervisors: Marie Frier Hvejsel and Dario Parigi

gesture herein implies a systematic correspondence between that which we intend our constructions to *afford* and for whom, and the technical realities of how our constructions *afford* and with what resources. Simultaneously identifiable as physical realities, *gestures* like Asplund's represent a positive potential as small-scale, real-life laboratories, across research, education, and practice, to explore and expand design directions for what architecture can and should do.

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Chapter 9
They Are There to Be Perceived: Affordances and Atmospheres

Tonino Griffero

9.1 The Crucial Role of Affordances

Let's imagine the entrance hall of a major banking institution, with its pretentious decorations and furnishings, fine paintings and sculptures, and an imposing marble staircase in the middle, surrounded by neoclassical columns. This certainly impressive *lived* space may *express* (i) an antagonistic atmosphere of power for those who venture there in search of a loan (whence the impulse to move slowly and warily, to leave the center of the room and take refuge in protective nooks and crannies), and (ii) a syntonic atmosphere of proud belonging for an employee who has developed a strong esprit de corps (whence their proud strut in the middle of the hall). This example clarifies, against any projectivistic relativism, that different atmospheric feelings (or, better, moods) are just relatively different felt-bodily filterings and resonances to the *same* quasi-objective and first-impression atmosphere that I call *prototypical*.[1] Of course, this is the case as long as—with a closer analogy with qualitative invariants such as James Gibson's *affordance* (1986) and, before that, Kurt Lewin's Aufforderungscharakter (valence) (1936, 166), Kurt Koffka's

[1] Without fully embracing the radical neo-phenomenological campaign of desubjectification of all feelings initiated by Hermann Schmitz in the 1960s (for an introduction to this philosophical stance, see Schmitz, 2019), I prefer to admit (at least since Griffero, 2014, 144) that there are three different types of atmospheres: prototypical atmospheres (objective, external, and unintentional, sometimes lacking a precise name), derivative-relational ones (objective, external, and sometimes intentionally produced as well as dependent on the subject/world relationship), and even some that are spurious because of their relatedness (subjective and projective, that is, also related to single objects and projected by the subject to the outside world).

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physiognomic character (1936, 359–367) and especially Wolfgang Metzger's Wesen (1941, 61–70)[2]—the atmosphere does not completely change based on the observer's needs and dispositions, and as long as it cannot be fully explained by social practices and cultural conventions. The bank's prototypical atmosphere imposes its affective salience, namely an architectural atmosphere of imposing vastness and impressive authority, by triggering both (i) shyness and (ii) pride, obviously among other more nuanced resonance effects. It does so thanks to the expressive affordance (refusal/invitation) inherent to its material-symbolic elements. This simple example[3] already shows the crucial role of affordance theory within my own aesthetic phenomenology of atmospheres (atmospherology). Nevertheless, when I suggested, at first rather roughly, a link between atmospherology[4] and the ecological theory of affordances[5] (Griffero, 2014, 47–54), I was certainly not yet fully aware of the constructive interaction—indeed, almost an elective affinity—between the two notions.

The aim of this essay is to explain atmospheric feelings as qualities supervening on expressive affordances (i.e., environmental qualities influencing the mood of the recipient emotionally) and at least partly resulting from the not necessarily pragmatic effect of more or less convergent systems of them. First, however, let me briefly explain what I mean by *atmosphere*.[6] Despite its both ontological and epistemological uncertainty (much like that of *affordance*), this concept has gained increasing relevance in all the Humanities that have subscribed to the affective- and embodiment-turn. An *atmosphere* is that *something more* one senses or perceives[7] *in the air*, that is, a feeling poured out into a certain (pre-dimensional) space, inextricably linked to felt-bodily resonances and whose qualitative holistic-mesoscopic

[2] Provided that "the properties of essence [or being; NdA] are neither subjective in the local sense nor in the causal sense," and have a phenomenal priority irreducible to an associationist explanation, Metzger claims that "the theory of empathy, according to which the Gestalt qualities of perceptual things are 'actually' the feelings of the observer, which they somehow 'transfer' into those things, is not a continuation of the theory of the Gestalt quality of feelings, but the complete destruction of its actual meaning and a clear fall into atomistic modes of explanation" (Metzger, 1941, 61, 70).

[3] It is true that banks may look different, but I doubt that they can do without a style that is impressive, intimidating, and a sign of power, or that a court of law could be based in the second floor flat of an anonymous building: their atmosphere of impressiveness and/or opulence can also be perceived by those who simply observe it from outside.

[4] The works of Tellenbach (1968), Böhme (2017a, 2017b), and, above all, Schmitz (1969, 2009, 2014) were seminal for my atmospherology (although they never refer to affordances). Due to bibliography constraints I will just mention some of the affordance scholars consulted for this paper (Michael, Still, Ambrosini, Bloomfield, Latham, Vurdubakis, Bonderup Dohn, Borghi, Chow, Costantini, Estany, Martínez, Gillings, Ginsburg, Heft, Jones, Lu, Cheng, Normal, Prosser, Reybrouck, Stoffregen, Turner, Kaptelinin, Withagen, Young, Zipoli Caiani).

[5] For an overview of the various positions on affordances I refer the reader especially to Heras-Escribano (2019).

[6] For a concise overview, see Griffero (2019b, 2020).

[7] Considering *true* perception to be an integrally pathic-corporeal state, there is no need to distinguish (as Straus, 1935 does) between sensing and perceiving.

nature, albeit largely intersubjective, is inaccessible to an epistemic-analytical (micro- or macro-) perspective. Indeed, it precedes any analysis and influences the perceiver's emotional situation from the outset, resisting (especially in prototypical cases) any conscious attempt at projective adaptation and epistemic correction.[8] Irreducible to occasional subjective vibrations, atmospheric feelings may within certain limits be traced back to a more or less homogeneous set of affordances understood as an atmosphere *generator* (Böhme) and thus be recognizable and linguistically expressable. By using the power of their affordances, atmospheres tonalize the affective space in which we (literally) enter and segment it through boundaries that are not geometrical but emotional.[9] Whatever the phenomenology of the way we encounter atmospheres—they can capture us resisting any attempted projective transformation, can be noted but not shared, can go unnoticed or even be changed by someone with an opposite and more intense mood, can change or at least take on different nuances over time,[10] etc.—they mostly occur as an *in-between* (between the perceiver and their environment).[11] In prototypical cases, they may even be prior to the constitution of the two poles.

Even talking about atmospheres' authority (Griffero, 2017a, 29–52) implies taking into account the role of affordances. An atmosphere, in fact, expresses more or less intensely what it *affords* a person to do and, above all (as we shall see), to feel. Needless to say, a theory of affordance-based atmospheres aims at enriching a long phenomenological tradition of emotional realism. According to this long-standing view, on the one hand, every lifewordly human relation to the world is primarily emotional-atmospheric (and not the detached-impoverished perception depicted by objective sciences), and on the other, the perceived-sensed world is by no means a meaningless sphere of *dead* properties (become an affective because of the more general *continual 'de-animation'*[12] of the world pursued by modern consciousness and physicalism) that the perceiver simply *tinges* with their private-idiosyncratic feelings, needs, and motives. Our felt-bodily interaction with the surrounding (lived) space is therefore always ruled by a physiognomic expressiveness[13] to which we

[8] I.e., the effort with which a percipient who feels attacked by a dystonic atmosphere tries in vain to transform it by projecting (unconsciously) his own emotional desires and even (consciously) acting in such a way as to modify the encountered atmosphere.

[9] They segment the space of our daily life by their being attractive or repulsive, relaxed or tense for example, thus also determining behavioral differences (but also differences in class, taste, cultural level, etc.).

[10] Griffero (2014, 136–139; 2021, 54–58). I would simply reply to Arbib's objection (Arbib, 2021, 257) that any change still assumes the atmospheric first impression as a parameter. In a theatrical performance, the scenes may well change, but the leading atmosphere does not change radically from scene to scene (one ironic moment certainly does not turn the whole of *Hamlet* into a comedy).

[11] I merely mention here the possibility that the atmosphere par excellence can be conceived of as a relationship preceding the relata, thus escaping the ever looming dualism.

[12] Scheler (1923, 239).

[13] Here I'm especially thinking of Merleau-Ponty's criticism toward the paradigm of an acosmic thinking subject (1945, 307, 310, 372, 405, 523, and *passim*). Cf. also his theory—unfortunately

mostly respond as recommended by phenomena themselves. What matters most for this approach, though, is that this affective physiognomy, through which the world *speaks* to the normal percipient (not the experimental subject), can hardly be explained according to the hydraulic model of psychic filling of the extra-psychic world.[14] Exactly as for affordance theory, for a neo-phenomenological atmospherology, the abovementioned bank hall could not be belittling or prouding in the absence of perceivers. This, however, does not mean that the atmosphere's (in this case) global affordance is the result of a simple projection from the inside to the outside, nor that it is completely different depending on the perceiver.

9.2 Fighting for a Different Culture

What led me to focus on similarities between affordances (ecological psychology)—better, non-Gibsonian affordances[15]—and atmospheres (pathic aesthetics and phenomenology)[16] is that both notions imply an embodied, non-representational, and situated approach to perception. They also both take the co-development and co-evolution of perception and the lived space very seriously, thus rejecting a culture that dualistically splits the inner self and the outer world, limiting perception to a representationalist-cognitive and disembodied process. Despite their differences, both notions actually promote a post-cognitivist and anti-representationalist approach to experience by focusing on a lifewordly communication with the world. They pay due attention to the *qualia* of the lived (not geometric-isotropic) space and their (even unconsciously perceived) invitations to act but also consider feelings (which cannot be reduced to the simple dichotomy of attractive/unattractive). This idea of the embedded affordance perception of a situated perceiver, certainly anticipated in some Gestalt notions (demand character, invitation valence, etc.), also suggests viewing this affective-perceptual meaningfulness as an affordance-based atmosphere. Moreover, since both affordances and atmospheres indicate that the perceiver cannot be separated from their environment-lived space, it is clear that in both cases the subjective/objective polarity loses its meaning. But if this is true for derivative atmospheres (which are much more frequent), it is not true for prototypical ones (see footnote 1). The latter allows for the dissonance between perceived

outlined in pages that are still vague-metaphorical—of horizons of significance (ibid, 523), atmospheric styles, and physiognomic characteristics.

[14] According to which when a quality (moreover affective) appears to us in the external world, it would necessarily be projected (hydraulically) by the subject on that external world, as such wrongly considered, physicalistically, lacking in qualities (especially tertiary).

[15] See Arbib (2021, §4.3).

[16] In brief: by pathic I mean (Griffero, 2019a) an aesthesiological attitude based on the fact of abandoning oneself to lived experience instead of judging it, of being subject to something instead of being subject to something. This obviously means criticising the dominant western attitude of activity.

feeling and real involvement, and their peculiar emotional authority imposes itself upon the perceiver even, if not especially, when they try to reject the atmosphere from which they feel involved.

Furthermore, both affordance theory and atmospherology, against the standard constructivist approach and its mentalistic/dualistic concepts, advocate for the thesis of direct perception, meaning that the environment (our peri-corporeal lived space, in my lexicon) is laden with affective meaning that perceivers *extract* (which they resonate with, in my lexicon) during the course of their sensory experience. Direct perceptual realism means that perception does not need to postulate either inner processes (representations, inferences, computations, manipulation of representations) or a mediated access to the world. Hence, my assumption is that an affordance-based atmosphere is a crucial part of our emotional life. Being directly detectable and not a mental-inferential construct, it tells us[17] what to feel with and through it.

9.3 Novel Insights into Atmospheres

Needless to say that I do not consider the breadth of the concept *affordance* problematic. On the one hand, (i) it helps me specify some generative aspects of the atmospheric *je ne sais quoi* (often used as an alibi of ineffability), that is, to explain atmospheric expressiveness also as the outcome of affordances or ecstasies (but not properties). On the other hand, (ii) it is useful to better explain if and when an atmosphere can be composed and thus even derive from possible interference of its components. Both assumptions give more substance to the true but too-vague thesis that atmospheres express a holistic *something more* whose components, if any, allegedly escape analysis.

To develop (i) Gernot Böhme's ontological notion of *ecstasies of things* may be very useful here. In this sense, atmospheric qualities are generated not by properties (accidents) of things (substances) but (among others) by their ecstasies: qualities that radiate "into the surroundings," thus taking "away the homogeneity of the surrounding space" and filling "it with tensions and movement suggestions."[18] Unlike properties, which exist even if they are only thinkable (the geometric ones for example), atmospheres are nothing but phenomenal appearances whose affordances tonalize their surroundings, give a specific (expressive) *voluminosity* to any situation, modulate our lifeworld (even segmenting it qualitatively), and exist as purely "potential" ones only in a very inappropriate way.

To articulate (ii), in order to narrow the atmospheres' holistic character, I claim that even an atmosphere resulting in a unitary and homogeneous affordance—the

[17] Without going so far as to claim—as later Merleau-Ponty did through too-metaphysical notions like chiasma and flesh designed to merge activity and passivity—that perceiving does not mean watching things but rather being watched by them, i.e., that seeing is always a response-gaze.

[18] See especially Böhme (2017b, 37–54, 23 for the quotation).

typical one, which has the greatest probability of being sensed given the situational constraints—might result from the convergence between different micro-affordances, thus differing (emerging) from its components taken in isolation.[19] Furthermore, I stress that a subsequent and more in-depth perceptual experience, maybe through discovering the other feeling possibilities offered by the lived space, might reveal some discordance (even leading to an opposite feeling) between the first holistic atmosphere and the one suggested later by discrepant and initially unnoticed sub-atmospheres. As the environment is full of affordances, we could also assume, borrowing some terms from the debate on affordances as cascades of increasingly specific and occasional constraints,[20] the existence of "cascades of atmospheres," "sequential," "nested," or "complex" atmospheres—whence also the hypothesis of hierarchies of atmospheres, niches of atmospheric feelings (so to speak), even of different rank (prototypical, derived, spurious). Whenever this happens, whether by reversal of the starting figure/background or focus/context structure, or simply by a longer exposure that makes a certain atmosphere perceptible or imperceptible, one thing remains clear: the first-impression atmosphere can certainly be modified and even declined (not always reflectively), but it still acts as an invariant, as a paradigm of the subsequent emotional changes.[21]

9.4 Not Acting But Feeling Possibilities

If affordances are opportunities for action and behavior, you may wonder what actions and behaviors are suggested by what I call *affordance-based atmospheres*. Herein lies the main difference between the traditional affordance theory and my atmospherology: according to a pathic aesthetics, atmospheric affordances of the lived space denote feeling possibilities. Through a meaning that is neither semantic or representational nor limited to the optic array, they specify not so much possible actions (sitting upon a horizontal surface at an appropriate height for us, for example), but rather what feelings they afford (feeling tense before going on stage, for example). Affordance-based atmospheres are ecological–emotional invitations

[19] An atmosphere as a whole may be the "supervening" result of micro-affordances not perceived as such, and even become an invariant in a certain culture (for this Böhme distinguisches between atmospheric and atmosphere).

[20] "For example; socks afford the easier wearing of boots which afford the attachment of crampons which afford the climbing of snow-covered slopes which themselves become "affordable", that is to say climbable" (Michael, 2000, 112).

[21] To give even just an idea of the problematic nature of the subject: this claim to differentiation of the perceived atmosphere implies that there are thetical and non-thetical (background) affordance-based atmospheres, central and peripheral atmospheres, potential and actual atmospheres (the only ones that are such in the proper sense), atmospheres in competition with each other (for various reasons), atmospheres that fall below the perceptual threshold, etc.

ontologically rooted in things and quasi-things.[22] They call upon us first of all to sense in a certain way (even contemplate) our peri-corporeal lived space, and only then to possibly think and act. Assigning the primacy not to action but to a pathic involvement means not to limit the affordance power to objects falling within perceivers' reaching space (as experimental psychologists often underline),[23] considering perceivers no more as actors but as situational *patheurs* involved in something that happens to them unintentionally.

This perspective requires extending the meaning of both atmospheres and affordances and going beyond the latter's strictly pragmatic meaning, in line with the long-standing migration that this notion has already undergone. So unless the meaning of "action" is extended to include every virtual affective motion (today called motor empathy, ideomotor simulation, etc.), it must be said that to an affordance-based atmosphere as a "value-affective rich ecological object" (modifying Gibson, 1986, 140) one responds first of all in an emotional way (wonder, disgust, awe and fear in the sublime, and even emotional palsy). At times one also responds with a distancing or a contemplative (broadly aesthetic) detachment, which, however, is not to be confused with a Cartesian static-cognitive observation. The pathic nature of atmospheres, though, does not take away the fact that they are relatively inter-observable and repeatable, and above all that they function as the (ecological but also social) *scaffolds* of affective experiences that would not be possible without them, thus helping solidify hitherto only inchoative emotional experiences and even establishing a socionormative affective appropriateness.[24]

A certain landscape affords/invites us to contemplate it in a melancholic way, a church affords/invites us to experience it in humility or at least in a controlled and meditative way, a successful party affords/invites us to relax, a wooden or velvet material affords/invites to indulge in touching it, a tree standing erect and resisting the powerful sway of the wind affords/invites us to feel strength and obstinacy, an airy and well-designed architectural space affords/invites us to occupy it and freely walk around—in all these cases we sense a meaningfulness made up of demands-invitations that are inherent in our lived space and effective without being necessarily true or adaptively functional, even if they are obviously related to the perceiver's *size* (understood here in a felt-bodily and not physical sense).

Even a saying like "black is lugubrious even before being black," often attributed to Wertheimer and obviously not transculturally valid, denotes for me not the product of occasional subjective vibrations but a general and quasi-objective atmosphere precisely irradiated by the black as affordance-ecstasy (at least in certain cultures).

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[22] This is a central notion in Schmitz, also denoting the ontological character of atmospheres (see Griffero, 2017a). For me, unlike full things, quasi-things are not endowed with borders, not separated from other things, not lasting over time and not inactive if not touched, etc.

[23] There are affordance-based atmospheres whose greatest affective resonance may require a static contemplation and even, if not above all – as Klages' "eros of distance" assumes (Klages, 1922) – a(physical and psychic) distance that is in principle unbridgeable.

[24] The lack of perception of the prevailing atmosphere, in fact, generates gaffes in those who do not perceive it and enables others to socially stigmatize them, etc.

As a quasi-objective affordance (or set of affordances), an atmosphere can even survive when no physical response is possible, as in the famous case of the phantom limb, where "the utilizable objects, precisely in so far as they present themselves as utilizable, appeal to a hand which I no longer have" (Merleau-Ponty, 1962, 95). This means that affordances atmospherically engage a perceiver even when the latter's body is no longer able to fulfill them: thus, things cease to be "manipulatable for the perceiver" and become "manipulatable in itself"; in other words, it becomes an (atmospherical) affordance in itself.

9.5 No Need to Fear Ontology

The question of whether both atmosphere and affordance are a relational or non-relational concept—something generated by a relationship between the subject and the world or prior to such a relationship and conditions of possibility of it—is still a controversy.[25] My first point is that atmospherology, especially when focusing on prototypical atmospheres and promoting an inflationary (non-metaphysical) ontological inventory, can disregard the almost paranoid ecological fear for reification. Quasi-objective atmospheres are certainly *entities* and not only interactions, properties (let alone merely physical ones), or necessarily agent-related aspects. As not physical (proper) things but quasi-things, much like affordances—at least according to some theories—they are there even though they may not be actually perceived. A room's tense atmosphere, for example, may not be noticed by those who enter it while feeling revved up, that is, without suitable circumstances, but it is still there as it pervades that particular lived space.

This atmospherological–ecological "rest-realism"[26] shows no fear of reification, nor does it shy away from multiplying entities. This is primarily because it partially dereifies the very notion of entity by making it fluid, and secondly because it devalues pragmatic questions like "for whom" and "when." A bank hall's atmosphere obviously does not afford a 2-year-old baby to feel awe or intimidation. However, this does not mean that its imposing vastness is not already potentially meaningful for the child, too, by triggering a certain felt-bodily resonance of dim disquiet. Consider, for example, the atmosphere of narrowness that is idiosyncratically privileged by infants for its enveloping and protective character, while being felt as suffocating by adults because of the *same* felt-bodily resonance (emotional narrowness). Only this ontological-realist interpretation of atmospheres, after all, can account for the rich phenomenology of possible atmospheric encounters, including the dystonic perception of an atmosphere, the distinction between perceiving it and being really involved by it, the mood resistance to a manipulative atmosphere (think of

[25] For a recent approach to atmospheres and affordances that completely excludes their relationality in favor of a fully immersive holism prior to any relationship, see Begout (2020).

[26] It is the basic degree of realism that is sufficient for the lifeworldly intersubjectivity (Griffero, 2021, 67–83).

experiences that are transgressive or at least freely randomized with respect to what the disciplinary power wants), the reversed atmospheric feeling (the sadness suggested by intolerable beauty, for example), etc.[27]

For both affordances and atmospheres, one may wonder if they are merely dispositional environmental qualities. A mutualist–dispositionalist perspective can only be maintained here cum *grano salis*. In fact, if from the empirical and first-person perspective atmospheres only are felt when they manifest themselves at a given time and in the *right circumstances* (when the feeling they afford is complete), from the ontological and third-person one they exist, at least for a reference class of potential perceivers, even though no one is feeling them at this moment or is not (yet) aware of them (which is what perhaps happens most often).[28] This means that they are a feature of the environment even before manifesting themselves.

9.6 Felt-Bodily Resonance

Even though a lived space may trigger uncountable affordance-based atmospheric feelings, these are always only different filterings and resonances of the *same* atmospheric first impression. Whether lit candles may trigger an atmosphere of romance in an intimate restaurant or an atmosphere of unease and fear in a dark cellar, these are just different atmospheric feelings (token) depending on an invariant atmosphere (type) produced by the reduction of brightness, the enveloping presence of shadows, the desubstantialization of objects, etc.

However, this partial variability suggests that, like affordances, ecological *facts* like atmospheres cannot be easily mapped out and analyzed. Nevertheless, they are always relative to dispositions of the perceiver's lived body and not only, like pragmatic affordances, to their physical body-scaling or at most their perceptual body schema: being invitations to feel something (without necessarily doing something), they are not bound to the potential of the physical body, as a certain pragmatic fundamentalism would demand. Since ecological psychology seems to be blind to the notion of *felt body* (*Leib*), it sometimes seeks help in neuroscience, without realizing that brains as such neither have proper experiences or capacities nor are felt corporeally.[29] Therefore, if one wants to explain how to identify (not to measure!) atmospheric feelings phenomenologically, one would have much to gain from New Phenomenology's theory of felt-bodily communication. This theory assumes that one immediately feels environmental *bridge-qualities* (motor suggestions and synaesthetic characters) (Schmitz, 2011) and appropriately reproduces them in one's

[27] For an (also literary) phenomenology of these atmospheric "games" see Griffero (2021, 29–66).

[28] An analogy worthy of further investigation is Chemero's distinction (2003), borrowed from Dennett, between properties like "lovely" (existing independently of an actual perceiver) and "suspicious" (meaningless in the absence of the percipient's assessment).

[29] I gladly leave to neurophysiologists a deep – but not phenomenological! – description of the structure and processes that allow the perceiver to feel affordance-based atmospheres.

lived body thanks to a felt-bodily *alphabet* that is based on an endless modification of the contraction–expansion relationship.[30] Since I certainly cannot discuss this here, I would simply add that, being based on a first-person perspective, felt-bodily communication can neither fail to sense an atmosphere nor can sense an atmosphere that the lived space does not afford (put differently: from the first-person perspective no one is wrong in perceiving an atmosphere (where to find a criterion of *adaequatio* in fact?), which is quite different from saying that they are wrong in explaining its cause and origin). In fact, whereas the perception of affordances can also be ecologically incorrect (misperception) or give life to false affordances, for atmospherology even the mismatch between the atmospheric space that is largely agreed upon and its individual felt-bodily resonance cannot be properly considered a mistake, but only a different way of sensing the *same* atmosphere.[31]

9.7 Conclusion

Needless to say, the notion of affordance-based atmospheres can also be extremely useful in aesthetics: both in the broad sense of a philosophy of sensible knowledge (my pathic aesthetics) and in the strict sense of a philosophy of art. The effectiveness of art, in fact, also results from the influence of atmospheric affordances-ecstasies hovering "around" the work of art but condensed in it in a meaningful way. Art can exemplarily manifest feelings as well as their atmospheric turmoil (real demonic and quasi-thingly powers), but always in a controlled and manageable form. Something similar can be said of design and especially architecture, understood as a stage set producing sensuous atmospheres, a set of "gestures" ecstatically inviting the perceiver to feel and move in a certain way.[32] Further analysis of the added value of an aesthetic atmospherology is beyond the scope of this paper, which simply aimed at sketching a few observations on the potential benefits of the decades-long debate on "affordances" for a theory of atmospheres. Of course, much remains to be done about this intriguing issue.

[30] It includes notions like narrowness/vastness, contraction/expansion, direction, tension, dilation, intensity, rhythm, privative expansion/privative contraction, protopathic tendency/epicritic tendency, felt-bodily isle formation/felt-bodily isle decrease, etc. See Schmitz (2011) and Griffero (2017b).

[31] Nuremberg crowd can actually be "for them a thrilling atmosphere of national solidarity; for us, a chilling atmosphere of Nazi fanaticism" (Arbib, 2021, 258), but as a consequence of the same majestic, impressive, and immersive choreographic staging (simply filtered and politically addressed differently ex post).

[32] For more details on the application of the concept of atmosphere to aesthetics and architecture, see Griffero (2019a, 3–20, 99–136).

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Part IV
Psychological and Spatial View

Chapter 10
Affordances for Spatial Navigation

Lara Gregorians and Hugo J. Spiers

10.1 Navigational Affordances

Navigation is a fundamental part of life for many animals including humans. It enables us to move successfully through an environment from one place to another. Through this process, one needs to be able to perceive a space, understand it, and make decisions on paths and directions to take, often rapidly. Affordances are what the environment offers an individual to be able to complete these actions; for spatial navigation, we consider the environmental affordances that help build internal models that represent the environment and support navigation through it (Gibson, 1977; Epstein et al., 2015). Revisiting Gibson's classic introduction to the concept of affordances, the physical environment and movement are used as central examples. It therefore comes as no surprise that aspects of our environment that provide affordances—wall boundaries, landmarks, doorways, etc.—have been considered key examples of affordances that allow us to evaluate where we can and cannot go.

> A vertical, flat, extended, and rigid surface such as a wall or a cliff face is a barrier to pedestrian locomotion. Slopes between vertical and horizontal afford walking, if easy, but only climbing, if steep, and in the latter case the surface cannot be flat … The affordance of a certain layout is perceived if the layout is perceived. (Gibson, 1979, p. 57)

As Heft (1988) outlines, under the lens of affordances we look toward what environmental features objectively and psychologically offer an individual, rather than just what may be perceived. The theory of affordances is particularly useful for understanding spatial navigation as it highlights that components of the environment, which may otherwise be seen as circumstantial, are in fact key drivers of perception, action, and ultimately successful goal locating. Recent evidence

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indicates that navigational affordances are processed in the very early stages of scene perception, within as early as 200 ms of viewing a scene (Harel et al., 2022). In this essay, we will briefly introduce some of the key environmental affordances that have been studied in spatial cognition, exploring how they help us navigate, and evidence for how the brain processes them. We will then consider future avenues of research and evaluate the importance of lesser-studied and more intangible environmental affordances—such as affordances for affective responses (e.g. threat or relaxation) that are equally important for considering an environment for navigation.

10.2 Landmarks

Landmarks are one of the most widely discussed navigational affordances, acting as reference points that allow us to orientate ourselves in relation to the external world, to discern direction, and to decipher between otherwise similar spaces (Caduff & Timpf, 2008). A landmark is an element of an environment—physical or sensory—that is used to mark specific locations to aid navigation (O'Malley et al., 2017). This could be a concrete object, e.g. Big Ben in London, UK, or a small lone rock in the arctic ice; or a geometric form, e.g. a junction or a plaza (Safari & Moridani, 2017). Landmarks can also be classified as either global or local landmarks—the former indicating those that are visible across long distances from many points of view; the latter indicating those that are only seen in close proximity to one's current location (Noble et al., 2020). The way in which these two types of landmarks are used (and their effectiveness) has been debated with mixed results. Recent examination of this has come from the navigation test Sea Hero Quest, which captured data from over four million people navigating a virtual environment on mobile devices (Coutrot et al., 2018; Spiers et al., 2021). When the presence of local landmarks was compared to the presence of local and global landmarks, global landmarks were not found to improve wayfinding significantly, suggesting that they are not powerful wayfinding aids (Yesiltepe et al., 2019a). However, the presence of global landmarks and clear weather (as opposed to poor visibility fog) did correlate with improved wayfinding performance across different environments (Yesiltepe et al., 2019b). To better understand these nuanced differences, the specific roles and values of different landmarks and their spatial integration need further exploration.

Saliency is also considered important to the role of landmarks in aiding navigation; it has been suggested that the more visually unique the landmark, the more salient it is and therefore better remembered (Miller & Carlson, 2011). In cases where navigational abilities are compromised, such as Alzheimer's dementia (Tu et al., 2017), salient landmarks are particularly important; contrast colours, artwork, and lighting can all be used to boost saliency and improve wayfinding (Utton, 2009). However, landmark saliency is not always necessarily intrinsic to the item itself. Rather, it can be determined through the balance of three factors: (1) cognitive salience (the observer's conceptual point of view, knowledge, and preconceptions), (2) perceptual salience (the feature in question's ability to attract attention), and (3)

contextual salience (the circumstance and purpose of the journey) (Caduff & Timpf, 2008). Recent work has highlighted that some features that lack perceptual salience (determined from image processing) can take on important cognitive salience for navigation in virtual environments (Yesiltepe et al., 2021). For example, some small rocks may be a feature that marks an important turn, but are missed by standard image processing analyses to predict saliency (Yesiltepe et al., 2021).

The identification and spatial encoding of landmarks are supported by a circuit of brain regions including the functionally labelled occipital place area (OPA; a region of the visual cortex tied to visuospatial perception and path identification), parahippocampal place area (PPA; tied to encoding scene geometry and layout), and retrosplenial complex (RSC; linked to spatial-memory and broader environmental integration) (Janzen & Van Turennout, 2004; Marchette et al., 2015; Epstein et al., 2017). These three regions are central to scene processing in particular and show greater response to viewing scenes than to object stimuli (Bonner & Epstein, 2017). It is worth noting that the functional region RSC overlaps with the anatomical region in humans described as the retrosplenial cortex, but the RSC also tends to include broader medial posterior parietal regions (Epstein et al., 2017). When learning a route via a focus on landmarks, activity in RSC has been found to encode spatial and temporal relations between neighbouring landmarks (Wolbers et al., 2004). The RSC also appears to operate alongside the PPA when passively viewing scenes; the PPA is thought to encode the fixed features that form scenes in order to create a representation of the layout, and the RSC situates this scene within the wider environment to aid navigation to goals (Epstein, 2008). Similarly, the parahippocampal gyrus is able to distinguish navigationally relevant landmarks (those at decision points) from landmarks at navigationally irrelevant locations and store this spatial information regardless of memory or focus on the given objects (Janzen & Van Turennout, 2004).

10.3 Detecting Navigable Paths and Boundaries

Understanding the environment around us involves perceiving a given space, its configuration, and our location within it. The work of Bonner and Epstein (2017, 2018) has contributed significantly to our understanding of how navigationally relevant affordances (i.e. information about where you can and cannot go) are processed. To explore this, virtual rooms were generated with three walls and up to three exit options. Layouts that offered similar exit paths showed similar activation patterns in the OPA, whilst those with different route options had dissimilar activation patterns (Bonner & Epstein, 2017). This encoding occurred regardless of other visual noise or distraction in the scene, or whether a person was actively focusing on the act of navigating or not, demonstrating that navigational affordances are automatically extracted from visual information, and that visual similarities (e.g. geometry of space) are not driving the effects seen in the OPA. The OPA appears to be coding specifically navigational information during the early stages of scene

processing, as fast as 200 ms from viewing a scene (Harel et al., 2022). Bonner and Epstein (2018) have gone on to further unpick the computations that lead to the OPA's mapping of possible paths, using convolutional neural networks to show that affordance information and extraction can be predicted through feedforward computations. Boundary-defining junctions—i.e. where surfaces such as walls or floors meet—and large, extended surfaces were found to be highly important features in these computations. Whether the PPA and RSC are also able to specifically distinguish navigational rather than purely spatial affordances is still unclear.

Djebbara et al. (2019, 2021) have also studied the impact of affordances that indicate where you can and cannot go, deducing that this type of affordance processing is embedded in early perceptual processing. Using mobile immersive virtual reality, participants viewed a single doorway of varying width that led onto another space and consequently were informed whether to pass through or not. On viewing these environments, the parahippocampal region and occipital area covaried with the given "passability". When moving toward the doorway, the supplementary motor area (tied to the control of movement) and posterior cingulate cortex (potentially balancing internal vs. external attention) varied with the change in action. Their results suggest that "sensorimotor dynamics reflect behaviour-relevant features in the designed environment" (Djebbara et al., 2021)—that perception of sensory cues, cognition, and action unfold in parallel and are innately tied to (the potential opportunities for) movement as dictated by body and environment. Within this, the landscape of affordances is in itself dynamic; movement leads to changes in environmental affordances, and how these are chosen or capitalised on may be influenced by estimations of what future affordances these choices could create, and how they relate to a larger goal (Pezzulo & Cisek, 2016).

Boundaries can also be pivotal, both in affording a measure of containment, but also playing a role in spatial memory, by "anchoring"1 objects to a space (Zisch et al., 2022). Locations of objects can be learnt relative to surface geometries, activating the right posterior hippocampus, or learnt relative to landmarks, activating the right dorsal striatum (Doeller & Burgess, 2008). Akin to processing navigational affordances, the OPA appears to play an important role in processing boundaries (Julian et al., 2016). This is consistent with the OPA processing information in the visual scene about where one can or cannot move, such as boundaries defining a region for movement or paths allowing for future travel. Notably, boundaries can also be more abstract, being derived from an understanding of the segregation of different regions within a city (Griesbauer et al., 2021).

10.4 Line of Sight

Spatial configurations determine what is visible within a person's line of sight—another spatial characteristic that has been shown to be an important affordance for spatial behaviour. In any environment with enclosure, the line of sight to other locations will vary from each location and viewpoint. In terms of choosing route options,

research suggests that people prefer to follow paths along the straightest line of sight (Dalton, 2003). When presented with binary options of two paths to search for a target location, the option with the longest line of sight will tend to be chosen and people will spend more time looking at the option with the longer line of sight (Wiener et al., 2009). This makes logical sense in that the region with the longer line of sight is likely to contain more locations for targets to be located in. Longer lines of sight in cities often relate to major routes, as those with small lines of sight may be dead ends or contain less shops or buildings people might visit (Hillier, 1996). Visual integration has also been linked to improved wayfinding performance (Yesiltepe et al., 2019b).

10.5 Spatial Configurations

Understanding a singular space naturally extends to the need to understand a string of spaces. The positioning of related spaces impacts what path options are available and what regions of open space can be traversed. Spatial configuration, as defined by Hillier (1996), considers how the relationship between two spaces alters through their connection to a third space. The field of Space Syntax proposes techniques for analysing spatial configurations and relates this to human behaviour (Hillier & Hanson, 1989; Hillier, 1996). For example, a street network can be deposed into a graph in which the streets are nodes in the network. Using graph-theoretic measures of centrality, it is possible to quantify how strongly connected different streets are in the network (Fig. 10.1).

Highly integrated streets (high closeness centrality) will tend to have more amenities and be nearer the centre of the environment, e.g. Oxford Street in London, UK (Hillier, 1996, Fig. 10.1d). Space Syntax approaches can explore street networks both across the global network or with a different radius to give measures of local integration and global integration (Fig. 10.1e–g). When participants were asked to choose a direction of travel at a decision point from Google Street View images, they tended to choose the more connected street (deducing centrality from their current position) (Emo, 2014). Eye-tracking data indicates they do so by focusing attention on the spatial geometry of the environment (Emo, 2014, Fig. 10.2). Well-connected spaces afford *intelligibility*, acting as visual cues that ascertain what is beyond the visual field, connecting local properties to the larger spatial structure (Hillier, 1996). Better intelligibility has been linked to better wayfinding performance (Yesiltepe et al., 2019b). Affordances in which paths can be taken (e.g., one-way streets) have also been shown to impact navigation and representations of distance in virtual towns (Brunec et al., 2017).

Repeated exposure to certain affordances of spatial configurations during childhood may also impact navigational ability and route choice. Cities vary in how organised their streets are. Cities like Chicago (USA) are formed with a strongly rectilinear grid arrangement, whilst others like Rome (Italy) are much more miss-aligned with a nearly random arrangement. Testing over 390,000 people with Sea

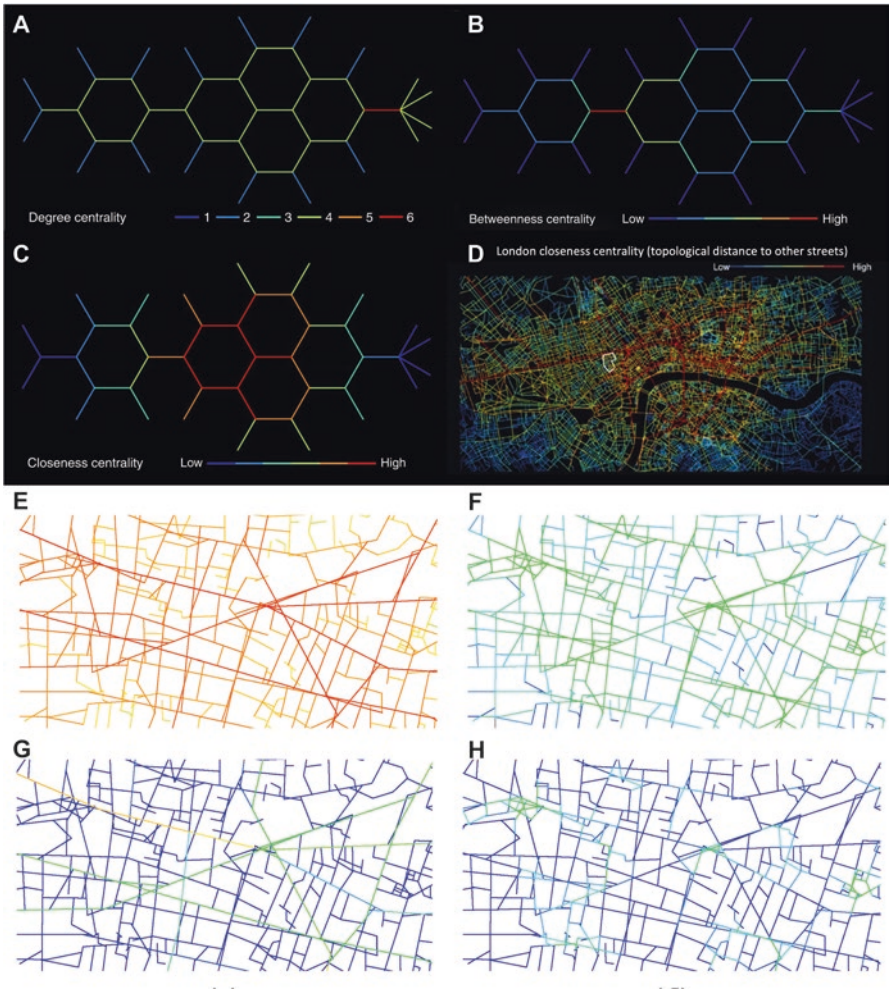

Fig. 10.1 Key centrality measures in Space Syntax analyses of street networks. ((**a**–**d**) Adapted from Javadi et al. (2017)). Each line identifies a segment street in a network. (**a**) Degree centrality denotes how many streets are connected to each street. Referred to as *Connectivity* in Space Syntax. (**b**) Betweenness centrality identifies the frequency that a given street might be encountered when travelling across the network. Referred to as *Choice* in Space Syntax. (**c**) Closeness centrality reflects how topologically close a given street is to all other streets in the network. Referred to as *Integration* in Space Syntax. (**d**) A real-world example showing central London (UK) mapped with closeness centrality. The white region indicates the section of London studied in Javadi et al., 2017. ((**e**–**g**) Adapted from Emo (2014)). Segment angular maps of London (UK) evaluating two components relevant to centrality at the global and local level: integration and choice. Red to blue colour scale indicates most integrated to most segregated streets. Segment angular maps break down axial lines (the longest line that fits the street) into segments, bookmarked by intersections with another line. (**e**) Mapping global integration of each street. Integration identifies a street's centrality within a network, i.e. how many streets must be crossed to reach all other streets (equivalent to closeness centrality, see **a**). (**f**) Mapping local integration, where only local surrounding segments are considered. (**g**) Mapping global choice. The *choice* measure evaluates the number of streets that would be passed through on a shortest-path journey between two points in the network (equivalent to betweenness centrality, Fig. 10.1b). (**h**) Mapping local choice. (Images combined and reproduced with permission under the Creative Commons Attribution 4.0 International Licence)

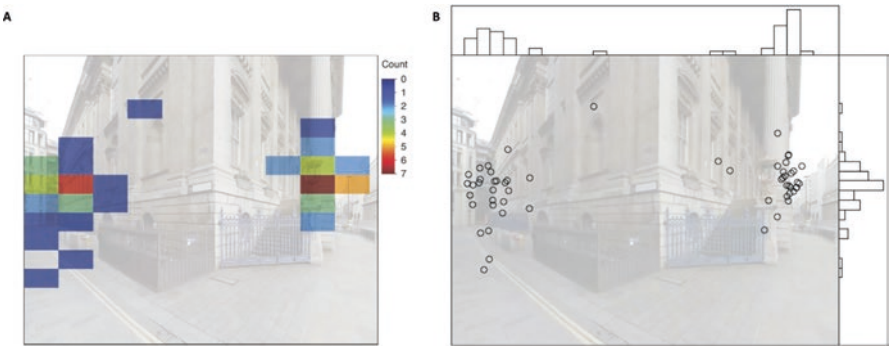

Fig. 10.2 Paths with a longer line of sight and more integration are viewed for longer. (Adapted from Emo (2014)). (**a**) Grid-form dissection of fixation point frequencies across all participants at one site. (**b**) Fixation density graphs for fixation points across all participants at the same site. (Images reproduced with permission under the open access Creative Common CC BY licence)

Hero Quest, we have found that growing up in countries with grid-like cities (e.g. USA) results in poorer navigation skills in environments that are more randomly arranged; the more random, the worse the navigation (Coutrot et al., 2020). In more grid-like environments, there is even a slight benefit from growing up in griddy cities. This may result from the fact that during development, the brain acquires repeated experiences of navigating with near 90 degree turns to reach destinations in griddy cities, or more diverse angles between paths in more organic cities or rural settings. This then may mean the navigator is more prone to make different assumptions about what will occur during navigation and make errors if the affordances in the environment (e.g. disorganised streets) do not match stored expectations. A similar impact of expectations in affordances can be seen in the navigation of multistory buildings, where floors in a building that differ in layout cause disorientation due to a mismatch in expectations (Hölscher et al., 2012). On the flip side, optimising for expectations in linear spatial configurations coupled with saliency between spaces may lead to better spatial learning and navigation (Zisch et al., 2014).

To examine how brain regions process information about the topology of street networks, Javadi et al. (2017) recorded fMRI data while participants navigated a film simulation of Soho in London, UK (Fig. 10.3). When entering a new street during navigation tasks, the right posterior hippocampal activity was found to increase when a new street had more connections (higher degree centrality/connectivity) and decrease when these went down, e.g. entering a dead-end. Activity in the right anterior hippocampus reflected changes in the new streets' closeness centrality/integration. However, in Soho, integration was confounded with a line of sight (more integrated streets were longer), so it remains unclear whether this response was specific to integration or to a longer view. Overall, the posterior hippocampus appears to process local information about street networks, and the anterior hippocampus may process the more global aspects of an environment.

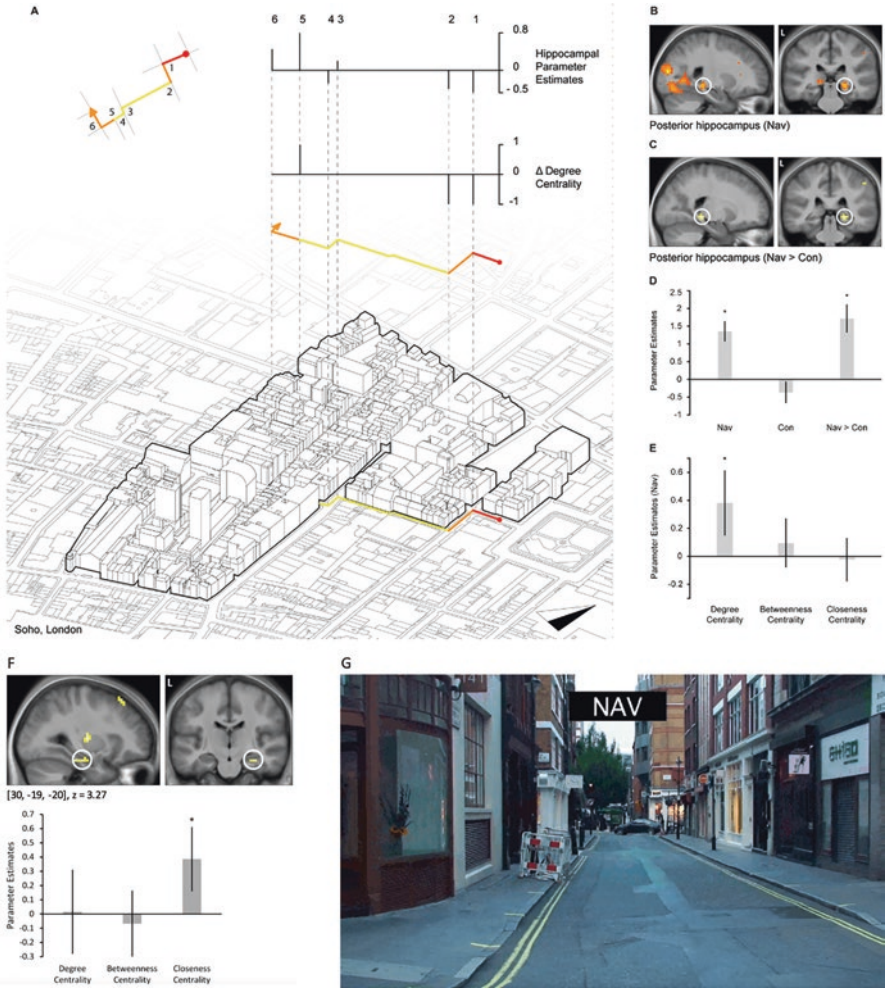

Fig. 10.3 Hippocampal activity tracking the local and global connections in street networks during navigation. (Adapted from Javadi et al. (2017)). (**a**) Top left: degree centrality plotted for each street segment for an example route in the fMRI study by Javadi et al. (2017). Right: axonometric projection of the buildings in Soho plotted on a map of Soho. Degree centrality of the route is plotted on the map and projected above. Above the route the graph plots the change in degree centrality for each boundary transition and the top graph plots the evoked response in the right posterior hippocampus at each of the individual boundary transitions (1–6). Analysis of this plot was not used for statistical inference (which was carried out within the statistical parametric mapping framework), but is shown to illustrate the analytic approach. (**b**, **c**) Right posterior hippocampal activity correlated significantly with the change in degree centrality for Navigation and Navigation>Control during Street Entry Events. Control = following route goals guided similar to a Sat Nav. (**d**) Parameter estimates for the mean activity in the right posterior hippocampus ROI for Navigation and Navigation>Control comparisons for a model containing categorical change in degree centrality. Error bars denote the s.e.m. (**e**) Parameter estimates for the mean activity in the right posterior hippocampus ROI for Navigation>Control condition for a model containing degree centrality, betweenness centrality, and closeness centrality measures. (**f**) Right anterior hippocampal activity increases on entering streets with higher closeness centrality (higher choice). (**g**) Example of frame from one of the movies used to simulate navigation during fMRI. Error bars denote the s.e.m. (Images combined and reproduced with permission under the Creative Commons Attribution 4.0 International Licence)

Recent recordings from the homologue of the posterior hippocampus in rats (dorsal CA1) have revealed further insights into how the hippocampus may process connected environments. In rats, it is possible to record the extracellular activity of neurons as rats explore and navigate. In the hippocampus, a large number of neurons show spatially localised firing, with cells firing in different regions of space, each active when the rat runs through the neuron's particular part of the environment it is active for. These neurons are known as "place cells" and are thought to form an internal map of space (O'Keefe & Dostrovsky, 1971). Changes in the connections between regions of space (e.g. blocking a path or a door) appear to have little impact on the map of the regions formed by the localised activity of place cells (Duvelle et al., 2021; Widloski & Foster, 2022). However, when resting between journeys, a sequence of place cells that represent locations away from the current location can become active, and these follow the new connections in the space (Widloski & Foster, 2022). Thus, the hippocampus appears to represent the possible paths through a space when rats are resting between runs; for humans, something similar may occur when we finish travelling down one street and enter into a new one (Javadi et al., 2017, Fig. 10.3). This replay (the process of mentally re-running the series of cell activations that would have occurred on a journey) may help update knowledge stored in the striatum about what the optimal actions to take are given the new connections within the environment, e.g. to avoid some streets that used to be helpful (Gahnstrom & Spiers, 2020). This may also help update knowledge in the prefrontal regions about possible alternative options (Patai & Spiers, 2021). Other evidence indicates that after seeing (but not traversing) a path to a rewarding but unattainable goal, the hippocampus will preplay this future, as yet untaken, path to reward during sleep (Ólafsdóttir et al., 2015).

10.6 Affective Affordances of Space

An environment with helpful landmarks, clear boundaries, and an intelligible layout will be easier to navigate than those that lack these features. However, it is not just visual and geometric affordances that make an environment easy or hard to navigate; affordances that impact affect also play a role. For example, features that allow for safety, comfort, calm, or excitement may make an environment easier to traverse or remember (Zisch et al., 2014), whereas an environment that is threatening, disgusting, or extremely noisy may be more of a challenge. Such affordances can come from the geometry or layout of the environment. Enclosed spaces, for example, are more likely to be avoided than open spaces (Vartanian et al., 2015). But affective affordances can also come unsurprisingly from other features present in the environment. Broader built-environment research has provided a variety of evidence to demonstrate how aesthetic aspects of our environments—including biophilia, colour, texture, lighting, geometry, neighbourhood wealth indicators (broken buildings), etc.—contribute to how people feel within or react to spaces (e.g. Vartanian et al., 2015, 2021; Hackman et al., 2019). A wide variety of factors can also impact

good navigational decision-making; the environment can afford the navigator a calm space to think, or cause the navigator to become angry or anxious, such as when dealing with difficult traffic driving across a busy city (Spiers & Maguire, 2008).

Animal cognition studies have tended to implicitly assume that affect or feeling is not relevant to spatial mapping, but there is some indication that affective responses induced by environments could impact navigation. Lighting, route choices, and novel environments can all provoke physiological stress responses in rodents (Bailey et al., 2006; cited in Sternberg & Wilson, 2006). Similarly, in humans, one might feel a sense of spatial unease if disoriented; a lack of landmarks may be stress-inducing; and many feelings are spatial-specific, e.g. agoraphobia (Jeffery, 2019; Sternberg & Wilson, 2006). In Zisch et al. (2014), the authors summarise how the brain creates representations of environments by walking the reader through the Louisiana Museum of Modern Art, noting how hippocampal cells might respond to this specific architectural space. The affective dimension of these mappings is considered, from the pleasure that might be experienced in successfully constructing internal maps and memories of space, to the delight of surprise that might be experienced on revisiting this (now familiar) space and discovering novel changes (i.e. remapping of place cell maps). Their concluding challenge, however, remains: understanding how feelings, which are afforded by the environment, interact with spatial representations and navigational strategies.

There has been some experimental work looking at questions in this intersection of human navigation and affective responses to built spaces. Kostakos et al. (2020) explored the affordance of lighting in the process of wayfinding, with results suggesting that though directive lighting (i.e. lighting that guides a route) does not improve wayfinding performance, it does reduce participant heart rates—perhaps an indication of improving cognitive processing, or an affective response to the aesthetic experience. Vartanian et al. (2015) demonstrate that rooms with higher ceilings are more likely to be deemed beautiful, but also activate structures for visuospatial exploration. Moreover, Erkan's (2018) results suggest that high ceilings can improve wayfinding performance and memory of space. These studies highlight connections between elements of our environments, affective responses, and consequent decisions about how we move.

10.7 Conclusions

There have been significant advances in recent years in understanding how environmental affordances enable humans and animals to make sense of an environment and navigate through it. Affordances such as landmarks, paths, and boundaries demarcate the potential for movement through a space or between spaces to a goal. The OPA, PPA, RSC, and hippocampus are all central to how these affordances are processed and translated into navigational opportunities, with scene processing occurring in the first 200 ms of perceptual processing. Behaviourally, Space Syntax has also offered tools to demonstrate the influence of spatial configurations and the

importance of centrality, integration, and intelligibility to how choices are made in navigation.

However, what is less considered in navigation is how these very same environmental affordances, and the environment at large, can induce affective responses. Affordances can dictate where you can and cannot go, but can also be alluring or repellent—these affective responses, through aesthetic processing, therefore can drive behaviours, physically and metaphorically drawing us in or away (Yazdani et al., 2012). How an inhabitant feels when entering a space—whether confident or unsettled, happy or scared—may factor into navigational choices and abilities. As such, their integration into spatial navigation becomes an obvious focus for future research.

Moving forward and learning from findings in neighbouring research fields, it will be important to understand what affordances, beyond the visual or "measurable", and certainly beyond the objective, are influencing navigation. Looking at how environmental affordances impact personal, affective experiences of space may allow us to better understand the relationship between the spaces we traverse, how we feel within them, and how we make sense of them.

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Chapter 11
Merging Affordances and (Abstract) Concepts

Anna M. Borghi

11.1 Introduction

11.1.1 Affordances: From Gibson to Embodied and Grounded Cognition

Affordances, said Gibson (1977), consist of the invitations that the world offers to us. Affordances of objects prompt our actions. In recent years, the notion of affordance has been re-evaluated because of its potential to highlight the relationship between perception and action. According to Gibson, affordances are neither subjective nor objective; they concern both the subjects and the environment, and they involve both perception and action. Thinking of perception and action not as sequential processes but as strictly interrelated and mutually dependent represented a fundamental step for theories, like grounded and embodied ones, that emphasize the importance of action for cognition. While the interrelation between perception and action of the Gibsonian notion of affordance has caused its later success, scholars adopting embodied and grounded views diverged from Gibson's externalist perspective, according to which affordances were simply a matter of the relationship between objects and organisms, with scarce attention to what happened "inside the observers head." They deemed the neural representation of affordances is relevant and proposed that affordances consisted of visuomotor associations in the brain (Ellis & Tucker, 2000).

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11.1.2 Object Affordances and the Physical and Social Context

This important shift in the study of affordances has been complemented more recently by another paramount change. Until some years ago, literature on affordances mainly focused on responses to single objects. Recent studies have emphasized that affordances are influenced by the physical and social context. Particularly relevant for this paper are studies showing that the social context and the social norms strongly influence affordances activations. For example, when we know that an object is owned by somebody else, we do not activate its affordances (Constable et al., 2011). Within a given context, a competition between multiple affordances might occur (Cisek, 2007; Pezzulo & Cisek, 2016). In recent work in our lab, we have shown that object affordances are highly variable depending on the context (e.g., Michalland et al., 2021—in-principle acceptance.) but also on the characteristics and intentions of the agents (e.g., Scorolli et al., 2014) and that children respond to objects more creatively compared to adults, who tend to repeat more stereotypical actions and to be more functionally fixed to specific actions (Rio, Lugli, Benassi, Nicoletti, Borghi, 2019, in preparation; review in Mazzuca et al., 2021). One of the challenges of future research on affordances is, in my view, to understand in which cases affordances are automatically evoked and whether and to what extent the context filters the activation of affordances (see Borghi, 2018, for an extensive analysis of this issue). So far, I have dealt with object affordances. Importantly, while most studies focused on motor affordances evoked by objects, in recent years some new proposals emerged that have extended the notion of affordances to sociocultural practices (Rietveld & Kiverstein, 2014). The notion of affordances as linked to sociocultural practices is very relevant to addressing the interaction between affordances, categorization, and language, and particularly that between affordances and abstract concepts, on which the next chapter will focus.

11.2 Affordances, Categorization, and Language

Many studies have investigated how object affordances are activated during the comprehension and use of language. Research on language and affordances has highlighted two important aspects. First, the fact that participants are sensitive to object affordances during language processing confirms that language is grounded in perception and action systems; nouns evoke a simulation of their referents, and verbs a simulation of possible actions. Second, evidence indicates that language constrains the activation of affordances. It activates stable rather than variable affordances (Borghi & Riggio, 2015)—for instance, language encodes, and we activate the size of objects and the subsequent grip to use when comprehending or using a word like “banana” or “cup.” However, we do not activate the orientation of the handles of the cup because it is mutable and changing. The authors showed that when participants read a sentence like “grasp the brush,” but not when we read the sentence “look at the brush,” they represent the grip (power vs. precision) the object

requires, as well as the canonical orientation a brush might have (Borghi & Riggio, 2009). In a similar vein, Costantini et al. (2011) showed that, when prompted by noun–verb combinations like "grasp" and "bottle" and "pour" and "bottle," but not "observe" and "bottle," participants are sensitive to the fact that the mentioned objects, e.g., the bottle, is close to us or not, thus can evoke affordances related to the actions of grasping and pouring. These examples show in a quite straightforward way that affordances might be activated because the words refer to objects which are clearly bounded and have a specific size, orientation, and location in space. And yet, even here, it might be debated whether we need to simulate the action fully during simple linguistic exchanges. More problems arise when we have to comprehend and use words, the referents of which are more detached from sensory modalities, i.e., do not directly evoke affordances. It is the case, for instance, of words expressing abstract concepts, like "truth" and "freedom." Do these concepts evoke affordances? Can research on affordances be important also to understand abstract concepts and words?

11.2.1 Concrete and Abstract Concepts and Affordances

Abstract concepts, like truth, are very complex and sophisticated, and mastery in their use has been deemed as the hallmark of human cognition (Borghi et al., 2017). Compared to concrete concepts like "chair," abstract concepts like *truth* typically activate less sensorimotor and more emotional and interoceptive properties and elicit more linguistic experiences; they collect very heterogeneous exemplars and are acquired later and through the linguistic modality rather than through perception. We do not contend neither that concrete and abstract concepts are dichotomously opposed, nor that there is a continuum going from very abstract to very concrete concepts. Rather, abstract concepts come in a great variety, from philosophical–religious concepts to numerical concepts, from emotional concepts to social ones (Villani et al., 2019). Hence, they can be represented as points in a multidimensional space defined by dimensions such as abstractness/concreteness, imageability, emotionality, linguistic Mode of Acquisition, etc. Apparently, abstract concepts do not have any specific relations with affordances. Instead, I think studies on affordances might represent one of the bases contributing to a full understanding of how abstract concepts are acquired, represented, and used. Here I will propose two claims. First, I will show that affordances might play a role in the emergence of abstract concepts. I will contend that to acquire the ability to develop and use abstract concepts, we first need to learn to respond to affordances and form affordance-based categories and then progressively abstract from them. Second, I will analyze social affordances that might influence the use of abstract concepts. Specifically, I will contend that, when we comprehend and use abstract concepts, the affordances to which we respond might be represented by other people. I will address these two issues in the following.

11.2.2 *From Affordances-Based to Goal-Derived to Abstract Concepts*

The ability to form and use abstract concepts relies on that to form affordances-based concepts. Consider a child interacting with the surrounding world (Fig. 11.1). First, she will form concepts based on common perceptual elements or common motor affordances. For example, she will form the category of cups, and that of chairs. The exemplars of the category of cups and chairs are similar to each other—their members have similar perceptual elements, and they afford similar actions, like drinking and sitting. This similarity among the category members doesn't concern only artifacts but also holds for natural kinds—e.g., exemplars of geranium are similar in shape and color, and afford to plant, to water, to avoid stepping on them. Once children are able to form categories whose members are quite similar to each other, they learn to form categories the members of which are not necessarily similar. Note that there is not necessarily a sequentiality between the two processes, but the second is certainly more complex and likely occurs later; furthermore, to accomplish it, the help of others is more crucial. An example is the so-called ad hoc and *goal-derived* categories studied by Larry Barsalou (e.g., Barsalou, 1983) in the 1980s. Goal-derived categories collect examples that are perceptually dissimilar, but share common goals, like "things to take on the camping place." Being able to form such categories implies being able to flexibly put together elements based on the context, disrupting similarities based on the correlational structure of the environment. Importantly, for these categories, the role of sociocultural practices becomes more crucial—their members are put together not because they have

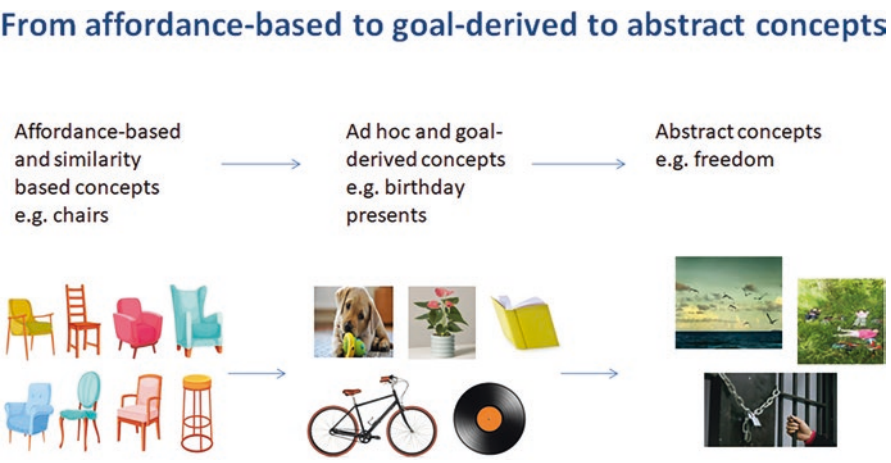

Fig. 11.1 Concrete concepts generally collect similar exemplars with common affordances; ad hoc and goal-derived concepts keep together perceptually dissimilar exemplars with different object affordances but based on common sociocultural practices; abstract concepts collect dissimilar exemplars the affordances of which might be based on common sociocultural practices

common perceptual elements and evoke common affordances, but due to the goals that reflect practices existent in a given culture. Which role do affordances play in the forming and consolidation of these categories? Certainly, motor-based affordances do not play a primary role. Consider a category like "birthday presents," which in Western cultures might include exemplars as heterogeneous as records, pets, plants, books, and bicycles. The exemplars of this category do not have much in common and activate motor affordances that are quite different—for instance, pets afford caressing, plants afford to water, and bicycles afford to ride. Yet, the members of this category share affordances related to the same sociocultural practice—for example, objects and entities that are "birthday presents" are typically made or chosen carefully, thinking of a person, and they are donated to this person in a generally jolly situation. Motor affordances are typically evoked by single objects or entities, whereas affordances related to sociocultural practices allow generalization. Notably, language might play a critical role in going beyond motor affordances, helping us put together categories that assemble heterogeneous exemplars through a common label.

Consider now typical abstract concepts, like *truth* or *freedom*. Similar to goal-derived categories, their exemplars are quite heterogeneous and not perceptually similar. In our view, the ability to form and use abstract concepts implies great flexibility and relies on the capability to build categories whose members are not perceptually similar and that are low dimensional, i.e., the members of which do not have many common elements. Importantly, by forming novel abstract concepts, we act on the environment and transform it. We do not adopt a bottom-up process, which involves simply responding to environmental stimuli. Rather, we actively arrange in novel ways the stimuli we are exposed to, based on a criterion that is defined top-down. This process is often performed together with other people; it is a collective process. What is the role of affordances here? Motor affordances do not play a role—they might be evoked by the single exemplars of a category but are not related by the category as a whole. Yet, affordances, as derived by sociocultural practices developed within a given cultural milieu, might play a role in forming these categories. For example, in many of our societies, the concept of *freedom* might remind us of the practice of exiting prison. Note that the claim I made is quite general and might apply to abstract concepts as a whole—abstract concepts might be formed based on affordances related to sociocultural practices. However, this claim might be more compelling for some subkinds of abstract concepts. For instance, the role of sociocultural practices might be more influential for the representation of philosophical–religious concepts than for the representation of emotional concepts, while motor affordances might be more relevant for abstract concepts related to numbers (small numbers, until 10) and spatial concepts. Future research should investigate in-depth the relationship between subkinds of abstract concepts and different kinds of affordances.

11.2.3 Abstract Concepts and Social Affordances

As anticipated, we can refer to object affordances but also consider affordances in a broader sense, not limiting the application of this notion to motor affordances related to specific effectors. Other people might offer us affordances—in recent years, these affordances have been named social affordances (see Fig. 11.2). For example, Gentilucci and colleagues (e.g., Ferri et al., 2011) have shown that other people may yield social affordances, e.g., opening their mouths to invite us to feed them. Here I contend that, when we process and use abstract concepts, we actively search for the help of other people, which represent for us a kind of social affordance. Consider what happens when we read or listen to an abstract concept expressed by an abstract word. As argued elsewhere (Borghi, 2020; Borghi et al., 2021), we might experience more uncertainties in grasping the meaning of abstract than of concrete words: for example, we might be unsure of the correct meaning of the word "democracy." Even in the cases in which we feel we know the word meaning, we might be unsure whether and to what extent the meaning we know is shared with others. For example, a scientist might think that she has a clear definition of the notion of "representation," but might be unsure of the close correspondence between

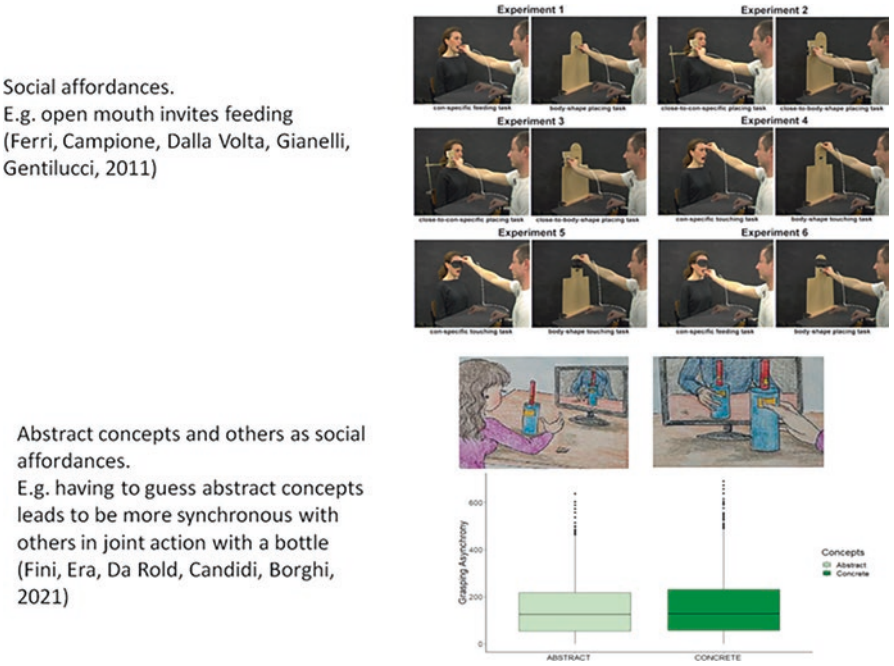

Fig. 11.2 Social affordances. In the study of Ferri et al. (2011), open mouth invites the feeding action. In the study by Fini et al. (2020), having to guess words, the abstract ones, for which the experimenter's suggestions are crucial, lead participants to be more synchronous with the avatar embodying her

the meaning she intends with that used by other scientists. With abstract concepts like "democracy" and "representation," we might therefore need to rely on others more than with similarity-based concepts, either to ask them the meaning or to negotiate it with them. We have called this process social metacognition (Borghi et al., 2019), to emphasize the fact that it involves a meta-cognitive process of self-evaluation of our own knowledge (Shea, 2018), and that, if the outcome of the process is a negative evaluation, it involves reverting to others. In this situation in which we need help, others can scaffold us; they represent anchors that help us clarify or redefine more clearly and compellingly the conceptual meaning. We have argued elsewhere that because we feel we need others more, we might tend to be more collaborative with them (Borghi et al., 2021). The presence of other people can thus offer affordances from which we benefit. There is, however, a difference between the notion of social affordance investigated, for example, by Ferri et al. (2011), and the one we refer to when speaking about abstract concepts. In the study by Ferri et al. (2011), participants respond to a movement of others—the opening of the mouth—that invites action from their side. In the case of abstract concepts, instead, people actively search for others to rely on their competencies, and this influences their motor behavior toward others. The authors (Fini et al., 2020) have recently shown how this process might occur. Participants had to guess which abstract or concrete concepts some images referred; a different experimenter showed them the concrete and abstract concepts. When they were not able to guess, they could ask the experimenter for help. They were told that, after the guessing phase, a joint action phase with an avatar embodying the experimenter would follow and that then another guessing phase would follow. Participants tended to move toward the object more synchronously with the avatar, which embodied the experimenter who had helped them guess abstract than concrete concepts. Consistently, they had the feeling that they needed them more for the guessing task, and that abstract concepts were perceived as more difficult to guess without others' help. In this case other people can be conceived as offering social affordances.

11.3 Conclusion

The notion of affordance posits important challenges for the investigation of language and abstract concepts. On the one hand, it shows that language is grounded in the sensorimotor system, while on the other, it indicates that language operates at an abstract level, filtering and selecting information derived from affordances—for example, language encodes stable but not variable affordances. In this chapter, I have outlined two different ways in which literature on affordances can be relevant for the study of concepts. First, affordances might play a role in the emergence of abstract concepts. When we form concrete concepts, we typically collect perceptually similar elements, which have common motor affordances. When we form abstract concepts, instead, we must learn to avoid focusing on motor affordances elicited by single objects. We have to flexibly put together categorical exemplars

based on affordances that rely on common sociocultural practices. Second, other people's presence and scaffolding role might be particularly crucial for the acquisition and use of abstract concepts. Hence, other people might be sources eliciting social affordances. The extent to which these two processes are modulated by different kinds of affordances (motor affordances and affordances linked by sociocultural practices) and by different kinds of abstract concepts remains an open issue for further research.

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Chapter 12
Perceptual Space as a Well of Possibilities

Sergei Gepshtein

Everyone seems to know what space is. But the meaning of "space" varies from person to person and from one occasion to another. It varies among the academic disciplines concerned with spatiality, such as physics, psychology, and phenomenology, and among practical professions, such as architecture and filmmaking, stage design and creative writing. How can we reconcile this polyphony? Is there an underlying root concept of space? In other words, do these multiple and disparate concepts have a "focal meaning"? One manner of answering these questions is offered here, by considering a moving person who is sequentially exposed to specific possibilities of experience at different spatial locations. Reminiscent of the concept of affordance, the present account is concerned with possibilities of experience, rather than with actual experience, and it is trained on distributed patterns of perception and behavior, rather than on their piecewise characterization.

> The term 'space perception' is unfortunate because it suggests that space is something that we perceive. Only objects are perceived, and these objects possess a number of attributes—qualitative, intensive, and spatial. The term refers to the perception of the spatial attributes of objects, viz., their size, shape, stability, motility, and their distance and directional locations in reference to each other and to the perceiving subject. […] Space as distinct from these spatial attributes is a conceptual construct. (Harvey A. Carr, 1935)

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12.1 The Focal Meaning of Concepts of *Space*

It is striking how often concepts of space are introduced in terms of what space is not rather than what it is. Our epigraph is an example of this negative (apophatic) tradition.[1] One reason for this peculiar situation may be that *void* is a common connotation of *space*. It is natural to describe void in terms of absence.

Another reason may be that there exist numerous concepts of space, developed by the various disciplines and professions concerned with space. The concepts of space indigenous to physics are different from those indigenous to psychology, phenomenology, architecture, or literary criticism. Again, you will want to define *space* by negation, apophatically, in order to distinguish your concept from mine. Figure 12.1 is an attempt to organize these concepts visually—to grasp their variety and to imagine them as a system.

Given the striking variety of concepts of space, one may want to ask why these concepts are numerous and disparate and how they relate to one another. Is there an underlying fundamental *root* concept of space, from which the numerous domain-specific concepts are derived? Another way to render this question is to ask whether concepts of space have a "focal meaning," which is a concept occupying a central position in a network of concepts unified by their connection to that center or focus.[2]

Here I consider one manner of answering these questions, in the tradition of primacy of perception, i.e., assuming that our fundamental intuitions derive from perceptual experience.[3] The approach presented here is reminiscent of the framework of *affordance*, invented and articulated by the perceptual psychologist James Gibson (1966, 1979), then adopted in studies of design (Norman, 1999; Maier & Fadel, 2009). Gibson's work on affordance can be usefully construed as an effort to describe possibilities of molar (versus molecular) behavior offered to the freely moving individual by the environment.

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[1] Ironically, the quoted text opens a book titled *An Introduction to Space Perception*. The author opens the book on "space perception" by elucidating that the latter phrase is misleading, leaving the reader is left in the straits of uncertainty, which is particularly injurious because it is unclear what kind of uncertainty it is. Is the uncertainty linguistic, where the word "perception" is a common homonym, which could mean, e.g., the process of perception or its outcome? Or is the uncertainty of philosophical nature, where the author reveals his unstated ontological commitments, and which the reader is invited to tacitly share? Or is it an instance of professional signaling, and the author is merely trying to make a careful distinction between colloquial and technical terms?

[2] The notion of focal meaning is a modern reading of Aristotle's *pros hen* homonymy. (*Pros hen* is translated as "towards one".) According to Owen (1960) who introduced this reading, Aristotle was asking whether multiple meanings of the verb "to be" had "one focus, one common element." Similarly, one may want to ask whether the word "space" used in different disciplinary and professional contexts is a case of homonymy, where the word has the same spelling but different meanings.

[3] In recent memory, this tradition is best known for its defense by the phenomenologist Maurice Merleau-Ponty (1964), but it was advocated broadly in other intellectual traditions that include empirical philosophy (e.g., Locke, 1847) and experimental psychology (e.g., Titchener, 1921).

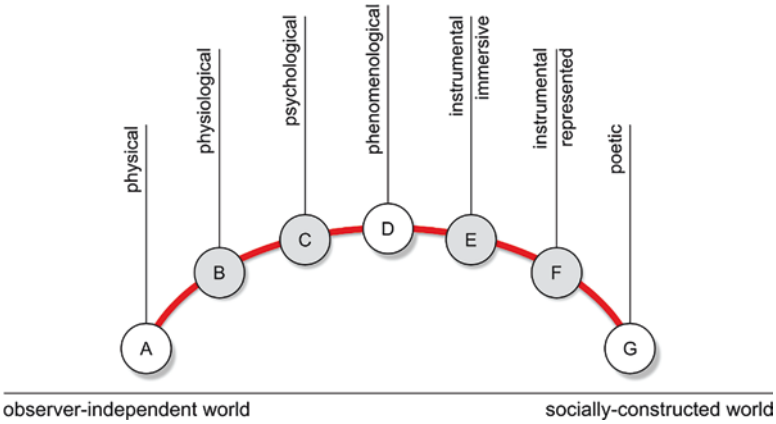

Fig. 12.1 Concepts of space. Concepts of space are shown on an arc stretched between the concepts that describe the observer-independent nature (left) and the concepts that describe artifacts of human culture (right). The white circles mark three landmarks that represent concepts of space in physics (A), direct experience (D), and imagination (G). Together with the stations represented by gray circles, we distinguish seven classes (or "species") of concepts of space (Gepshtein, 2020).

(**A**) Physical concepts are associated with various geometries and metrics, as in the classical Euclidian geometry, concerned with space alone, and the Minkowskian geometry, where space and time are combined in the four-dimensional manifold of space-time (Einstein, 1916; Jammer, 1954; Maudlin, 2012).

(**B**) Physiological concepts of space (the term "physiological space" was enunciated by Mach, 1906) relate to neural mechanisms of perception and behavior. Examples include properties of hippocampal neural networks that encode cognitive maps of the individual's surroundings used for navigation (Buzsáki & Moser, 2013) and neural networks in the cerebral cortex that underlie detection and discrimination of visual patterns (Ratliff, 1965; Gepshtein et al., 2022).

(**C**) Psychological concepts are used to construct *public* accounts of spatial perception and behavior, such as path selection and navigation (Tolman, 1948); accounts of behavioral environment (contrasted with geographical environment; Koffka, 1935; Gibson, 1979); and in theories and models of perception, such as the concept of binocular disparity used to explain binocular vision and stereopsis (Julesz, 1971; Marr, 1982; Howard, 2002).

(**D**) Phenomenological concepts are used in descriptions of the *private* accounts of space. For instance, much of Merleau-Ponty's seminal *Phenomenology of Perception* of 1945 is dedicated to phenomenological concepts of space. Bolnow (1963), Ströker (1987) and Morris (2004) offer more recent elaborations on the theme.

(**E, F**) Instrumental concepts are employed by the professions concerned with design and making. In station E, immersive space surrounds the individual, studied by designers of the built environment: in architecture, urban planning, landscape design, stage design, and by the newcomer professions concerned with virtual reality, augmented reality, and immersive cinema. In station F, the instrumental concepts associated with *represented* spaces are used, for example, in the analysis of figurative painting and traditional cinema (Arnheim, 1957; Pirenne, 1970; Kubovy, 1986; Kemp, 1990).

(**G**) Poetic concepts of space help to investigate imaginary or remembered spatial constructs, such as in the literary narrative (e.g., by means of literary chronotope; Bakhtin, 1982) or in retelling and reimagining the experience of the built environment (e.g., Bachelard, 1969)

Developed to counter the study of perception in exclusively analytical terms (Gibson, 1960), the framework of affordance applies to distributed patterns of perception and behavior. For example, consider the part of the environment called "ground." Grounds afford standing upon, walking upon, or crawling upon. These behaviors are some of the affordances of ground. Such different behaviors may have common constituents: elementary actions that add up to the behavior in question. But characterizing behavior in molar terms draws attention to those of its properties that are distributed across space and time, and thus define its unique character (e.g., as walking versus crawling).

Similarly, here I entertain the view that perceptual space is constituted by distributed patterns of possibilities of perception. On this view, understanding perception of space requires that we understand where possibilities of perception are located and how the possibilities available at different locations are organized in experience.

12.2 The Ring Model of Visual Space

Here I concentrate on visual space.[4] Visual perception of objects is mediated by perception of their multiple attributes, sometimes called visual *features*, which include generic features (such as the shape, size, and color) and specific features (such as eyes on a face or leaves on a tree).

Imagine that there was a law that described the perceptibility of visual features as a function of their viewing distance, which is the distance separating a feature from the perceiver's eye. Imagine further that, according to that law, the visibility of any feature was confined to a *band* of viewing distances. That is, the feature in question would be invisible from the viewing distances that are too long or too short (as we explain in the next section).[5] Several consequences of such a law are illustrated in Fig. 12.2.

Every panel of Fig. 12.2 is a plan view of the ground on which the perceiver moves along the path represented by the curved arrow. Panel A contains one visual feature represented by the black star. The filled "ring" is the region from which the feature can be seen (as predicted by the law of visibility illustrated in Fig. 12.3). The curved arrow represents the path of a mobile perceiver.

Panel B offers the same view as panel A, but it contains another feature represented by the white star. The lightly filled ring is the region from which this second feature can be seen, predicted just as in panels A.

Panel C contains the same rings as in A and B, shown together to illustrate the region of their intersection, shaded in this panel (and reproduced in panel D). The shaded region represents the region of joint visibility of the features represented by the stars.

[4] I use visual space to illustrate what appears to be a general property of perceptual spaces (including acoustic, haptic, etc.). The questions of how perceptual spaces differ from one another and how they are coordinated are addressed elsewhere (e.g., Gepshtein & Banks, 2003; Alais & Burr, 2004; Gepshtein, 2009).

[5] Failure to see features over long distance is a familiar to everyone. Failure to see features over short distance is less intuitive. The latter notion is explained in the next section ("A law of pattern visibility") and in Figure 12.5.

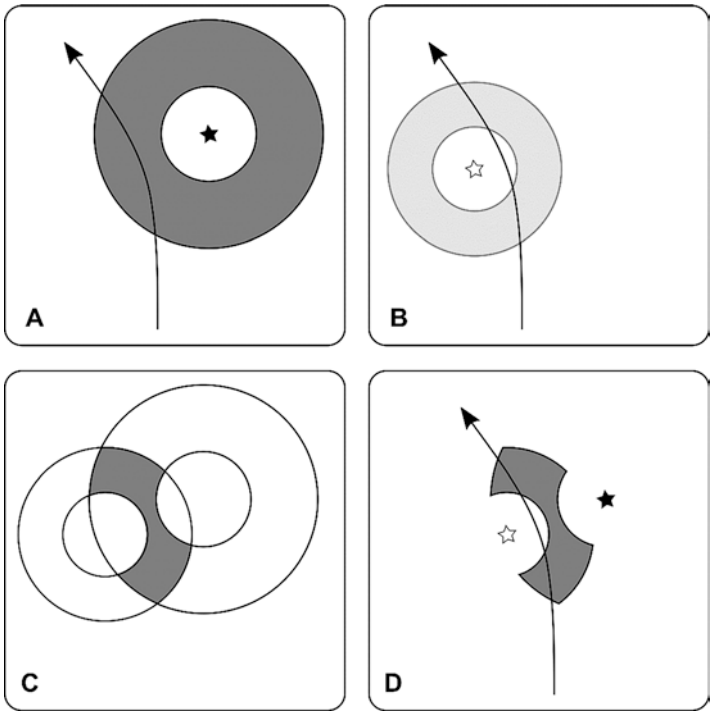

Fig. 12.2 The ring model of visibility. Every panel represents a plan view of the ground. (**A**) A single elementary object (a visual *feature*) is represented by the black star. The filled annulus (a "ring") is the region from which the feature can be seen, as predicted by a law of visibility explained in Fig. 12.3. The curved arrow represents the path of a mobile perceiver. (**B**) The same view as in panel A contains another feature represented by the white star. The lightly filled ring is the region from which this second feature can be seen, predicted just as in panels A. The curved arrow represents the path of a mobile perceiver, the same as in A. (**C**) The two rings from panels A–B are shown together, unfilled to illustrate the region of their intersection, filled. (**D**) The dark shape represents the region of joint visibility of the two features, derived by discovering the intersection of the annuli in panel C (Gepshtein 2020)

A person moving along the curved path will intermittently enter the region of *joint visibility*, where the path overlaps with the dark shape. Experience of this environment will consist of a series of visual events, which together constitute the continuous visual experience of the environment.

12.3 A Law of Visibility

12.3.1 The ring model of pattern visibility

Here I describe the rationale behind the ring model introduced in the previous section. Figure 12.3A is a visual scene that illustrates several typical properties of observation visual. Some of the *features* of this scene are window frames and

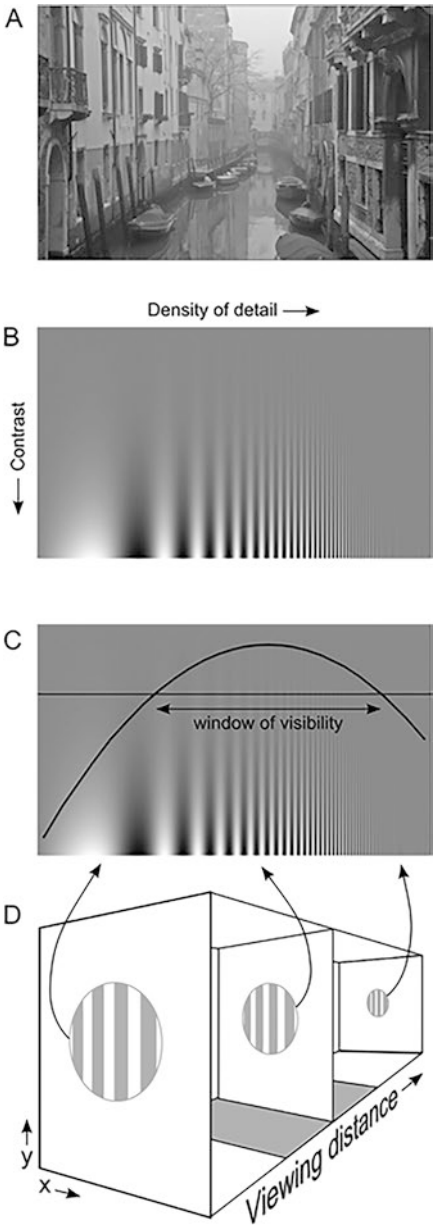

Fig. 12.3 Pattern visibility over distance. (**A**) A view of the built environment in which the density of detail and luminance contrast of visual *features* depend on distance from the viewer. (**B**) In this chart, the density of detail increases left to right, and luminance contrast increases top to bottom. The height at which the pattern is visible changes left to right, marked in the next panel. (**C**) The black curve marks the boundary separating the regions where image features are visible (below the curve) and invisible (above the curve). A portion of the horizontal line contained under the curve is the *window of visibility*—the range of densities of detail visible at this low contrast. (**D**) An image with a fixed density of detail is painted on a screen. The same screen with the same pattern painted on it is shown at three viewing distances. The contrast of the painted image is low,

mullions that form vertical arrangements whose apparent density depends on the viewing distance: the features viewed over long distances appear to have higher density than the features viewed over short distances. The *contrast* of these features also appears to vary with distance.

The image in panel B illustrates two factors that determine the visibility of such patterns: the density of detail and luminance contrast.[6] The density of detail (for which the term of art is *spatial frequency*) increases in the image from left to right, whereas luminance contrast (henceforth *contrast*) increases top to bottom. The reader is invited to inspect this image and discover that visibility of detail depends on both the density of detail and the contrast.

The same image is shown in panel C with a black curve superimposed, representing the boundary that separates image regions where image features are visible (in the lower region, below the curve) and invisible (the upper region).[7] A horizontal line is drawn at some law of contrast; a part of the line contained under the curve marks the range of densities of detail that is visible at this low contrast, labeled *window of visibility* in the figure. Notice that increasing the contrast (i.e., moving the horizontal line down) will increase the window of visibility so that that at high contrast the window of visibility will contain almost the full range of detail available in the image (visible at the bottom of the image).

In panel D, an image with a fixed density of detail is painted on a screen. The same screen is shown at three viewing distances; imagine the screen moving away from the perceiver, left to right in this figure. The fixed image has a low contrast, perhaps corresponding to the contrast marked in panel C by the horizontal lime. By nature of optical projection, increasing the viewing distance will lead to apparent increase in the density of detail (even as the density of detail in the image will not change).

The arrows drawn from D to C indicate how increasing the viewing distance will cause the same image painted on a moving screen in D will correspond to different horizontal locations in the chart in C. The leftmost and rightmost positions of the

←

Fig. 12.3 (continued) corresponding to the contrast marked by the horizontal line in panel C. By nature of optical projection, increasing the viewing distance leads to an apparent increase in the density of detail even if the image does not change. The arrows drawn from D to C indicate schematically how increasing the distance causes the same image painted on the screen to become invisible at the leftmost and rightmost positions of the screen. The range of viewing distances within the window of visibility is represented at the bottom of panel D by a gray area. This range of distances corresponds to the filled parts of rings of visibility shown in Fig. 12.2 (Gepshtein 2019)

[6] This image was first created by vision scientists Campbell and Robson (and described in Cornsweet, 1970). Luminance contrast is a measure of the difference between the lightest and darkest parts of the pattern.

[7] In vision science, this boundary is called *contrast sensitivity function* (Cornsweet, 1970; Kelly, 1979; Watson & Ahumada, 2016). Contrast sensitivity is defined as 1/L, where L is the amount of luminance contrast that makes the pattern just visible: the lower the contrast (called the *threshold*), the higher the perceiver's sensitivity (Green & Swets, 1966).

screen in D will correspond to locations on the horizontal line in C that fall outside the window of visibility (which is outside the part of the horizontal line contained under the curved boundary of visibility in panel C). Between those two extreme locations of the screen in D, one can find the range of viewing distances that matches the window of visibility shown in C. That range of viewing distances is represented at the bottom of panel D by a gray area. The same range of viewing distances corresponds to the filled rings in Fig. 12.2A and B.

12.3.2 Testing The Ring Model with Architectural Robotics

An interdisciplinary team of researchers tested predictions of this model on the scale of architectural design, in a study commissioned by the Academy of Neuroscience for Architecture (Gepshtein et al., 2016). The team used industrial robots to carry a projector and a large screen (Fig. 12.4). Animated images were presented on the screen, while the screen and the projector were moving synchronously to ensure a constant projector-to-screen distance. The projected images were *drifting luminance gratings*, which are blurred vertical bars moving left or right. Participants were seated as shown in the figure. Their task was to report, using a computer mouse, whether they saw leftward or rightward motion.

One result of this study is shown in Fig. 12.5. Two curves trace transition of visibility as a function of viewing distance: from nearly complete invisibility (at small distances) to nearly complete visibility (at larger distances), following a function predicted by the model. On the scale of architectural design, such transitions could happen over a relatively short range of distances: as short as half a meter: evident in gray curve in Fig. 12.5.

Notice that visibility plotted in Fig. 12.5 increases as a function of distance. This transition corresponds to inner radii of the ring of visibility shown in Fig. 12.2; one such ring of visibility is replicated in Fig. 12.5 at the right. Notice also that the changes of visibility plotted in Fig. 12.5 follow smooth functions rather than switch abruptly from low to high visibility. For convenience of description and modeling, differences between visibilities measured in different conditions are captured using the concept of *threshold*, noted in the preceding section and represented in Fig. 12.5 by the horizontal red line. For two conditions of measurement shown in Fig. 12.5, the threshold of visibility is attained at the viewing distance of about 2 meters at the contrast of 0.7% and at the viewing distance of just above 5 meters at the contrast of 0.3%. The sharp edges used to draw rings of visibility are thresholds of visibility.

Fig. 12.4 Apparatus for measuring pattern visibility on a large spatial scale. Two industrial robots carried a projector and a screen in a study designed to measure boundaries of visibility on the scale of architectural design. The two panels show a side view and a back view of a person facing the screen

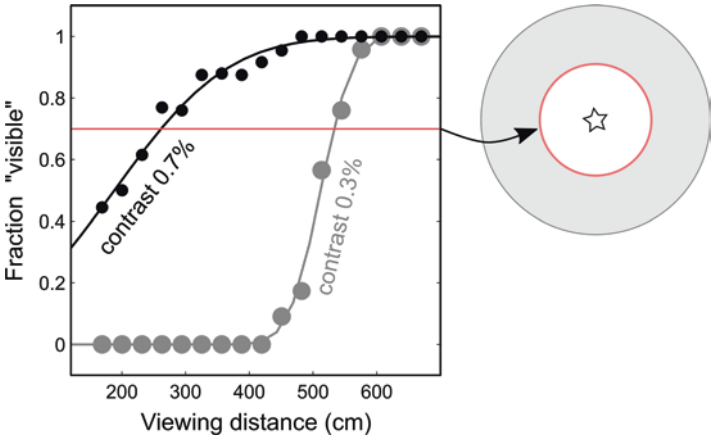

Fig. 12.5 Boundaries of visibility. Two curves trace changes of pattern visibility as a function of viewing distance. The distance is measured from the moving screen shown in Fig. 12.4. The results are plotted for two luminance contrasts: 0.3% in gray and 0.7% in black. Boundaries of visibility can be defined at a certain level of visibility, such as that represented in this figure by a horizontal red line. This boundary corresponds to the inner radius of the ring of visibility shown at right

12.4 Conclusions and Ramifications

12.4.1 The Focal Meaning of Concepts of Space

We started off with the observation that concepts of space are numerous and disparate. We asked whether there existed a root concept of space, of which the concepts used in different disciplines and professions were topical manifestations. The account presented here is a candidate for such a root concept.

The present approach is founded on the generic situation of a person who is moving and is sequentially exposed to specific possibilities of experience. This notion of sequential exposure to possibilities of experience is inherent in many concepts of space described in Fig. 12.1, including physiological, psychological, instrumental, and poetic. On this view, topical concepts of space differ from one another because various pertinent disciplines emphasize different aspects of experience even as the core process of sequential exposure to possibilities of experience remains the same. It is in this sense that our account of distributed experience can be thought of as a focal meaning of multiple concepts of space.

Against the connotation of space as void, our root account suggests that if space was void in the sense of absence of obstacles to movement, the void is structured. The structure is constituted by the boundaries of the regions of visibility illustrated in Fig. 12.2.[8]

[8] In fact, the possibilities of movement perceptible at different locations in the map will tell the person where the obstacles are.

Our approach is different from *geometric* approaches to perception of space, where perceptual space is described in terms borrowed from physics (e.g., Luneburg, 1950; Indow, 1991).[9] The alternative presented here is concerned with distributed possibilities of perception rather than with the geometry of space observed from a single location.

Circumscribing parts of spatial experience (as in Fig. 12.2) raises a litany of questions about how these parts are organized in the mind of a moving person. Different kinds of answers come to mind as we consider these questions "from below," in terms of perceptual forces of cohesion, and "from above," by viewing the distributed experience as a narrative.

12.4.2 Organization of Space from Below, Perceptually

In the view from below, the question is how fragments of perceptual experience are organized into perceptual wholes or objects. This line of inquiry was initiated by Gestalt psychology (Koffka, 1935; Smith, 1987) and it is continued today in experimental psychology, cognitive sciences, and neurosciences under the rubric of "perceptual organization" (Kubovy & Pomerantz, 1981; Gepshtein et al., 2008; Wagemans et al., 2012a, 2012b). Traditionally, studies of perceptual organization pursued two kinds of questions: about perceptual grouping and about layering of experience into figure and ground. Studies of *visual* perceptual grouping asked which parts of the visual scene are organized into experience as visual objects. And studies of visual figure and ground asked which parts form figures that appear to stand in front of the ground that "fills in" behind figures.

Questions of perceptual organization have been usually posed for a stationary person. Our analysis suggests a broadening of approach, in which perceptual groups and figure/ground layers can arise, break, or reform as the person traverses the boundaries illustrated in Fig. 12.2. In the broadened framework, perceptual organization in the stationary observer is discoverable by asking where the parts are available concurrently (as in panels C and D of Fig. 12.2).[10] And perceptual organization in the moving observer is discoverable by asking where parts of existing organizations become inaccessible or where new parts become accessible, causing perceptual reorganization.

The study of perceptual organization by a moving person has the potential to liberate this field of research from confines of the laboratory and two-dimensional stimulation. Gestalt phenomena are well known to designers, but famous illustrations of grouping and figure-ground segregation come from the early days of Gestalt psychology. With rare exceptions (Arnheim, 1977), fruits of later work on

[9] MacLeod and Willen (1995) and Koenderink and van Doorn (2013) are illuminating reviews of geometric models of perceptual space.

[10] In practice, such questions are raised by the architect, the city planner, and the landscape designer interested in the experience of architectural *ensemble*.

perceptual organization have not reached the community of designers working in immersive space (station E in Fig. 12.1; cf. Gepshtein & Snider, 2019).

12.4.3 Organization of Space from Above, Narratively

In the view from above, the question is how fragments of experience are organized into a larger narrative—verbal or nonverbal.[11] The narrative theorist identifies two aspects of the narrative. One aspect is *fabula*, which is the sequence of narrated events in their chronological order. The other aspect is *story* (sometimes called *sujet*) in which the narrator can reorder events in the interest of convenience or artistic effect, or to comply with demands of the medium, whether it is literary or painterly, cinematic or architectonic.

Our account of ordered experiences is similar to the concept of fabula. The arrow in Fig. 12.2 represents the person's path in the map. The path is akin to fabula in that it establishes the spatial and temporal order of events. A person moving along the path may have a series of experiences in the order defined by the regions of visibility encountered in the course of movement. If the path is likened to fabula, then the map is a representation of many fibulas offered by the environment.

Just as certain literary texts are said to be open to multiple ways of reading (*opera aperta* in Eco, 1984), one may argue that spatial environments are "open" in the sense that the moving person is free to choose her path. It appears, however, that the narrative openness of spatial environments is of different nature than the narrative openness described by Eco. In the artistic text, the fabula is fixed. In the spatial environment, the fabula is not fixed: It is selected by the moving person. It is in this sense that spatial environments are more "open" than artistic texts, open at both levels of sujet and fabula. Where many sujets may spring from the same fabula (along the same path), many fabulae (alternative paths) may spring from the same environment.

The choice of path by the freely moving person is the theme of a rapidly evolving area of empirical investigation. Concerned primarily with models of spatial reasoning and series of successive, spatially distributed choices (Maloney & Zhang, 2010; Snider et al., 2015; Miller & Venditto, 2021; Callaway et al., 2022), this literature engages many of the same concepts as narrative analysis, including counterfactual and abductive (retrograde) reasoning. But the connection between this literature and the analysis of spatial narrative is still to be made.

[11] If we construe narrative as a representation, then the relationship between the approaches "from below" and "from above" has the following structure. In the view from below, perceptual organization refers to how parts are rendered as a connected structure *in experience*. In the view from above, narrative refers to how parts are rendered as a connected structure *in a medium* (e.g., linguistic, pictorial, tectonic).

12.4.4 Space and Place

The relationship between the concepts of space and place is an influential theme in the literature on spatiality (Casey, 2013; Malpas, 2018). Studies of this relationship helped to overcome the mistake of conflating these concepts, with the caveat that the meanings of the words translated into English as "space" and "place" vary between languages, and some languages make no such distinction. In this literature, the concept of space is taken to be secondary to, and derivative of, the concept of place.[12]

Here I used the locution of space rather than place because the former is predominantly used in empirical studies of perception. Still, the account of parts of experience distributed over time, and organized perceptually or narratively, can be readily construed as an account of place. For example, consider this description of place by Malpas (2018, p. 39):

> The complexity of place is mirrored in the complex process of triangulation and traverse by which the topographical surveyor builds up a map of the region being surveyed. No single sighting is sufficient to gain a view of the entire region, multiple sightings are required, and every sighting overlaps, to some extent, with some other sighting…It is only through such journeying, sighting, and re-sighting that place can be understood.

One may reasonably assume that the content of sequential and overlapping "sightings" noted in the above quotation is determined by the regions illustrated in Fig. 12.2. This reading of triangulation and traverse described by Malpas prompts many a question about organization of experience, similar to those we have just discussed. How are the noted sightings integrated into the experience of place? More generally, how is experience of place constructed multimodally, from the spatially confined components arising through different sensory modalities? It appears that mapping these components—which is finding their boundaries and areas of overlap—amounts to an apt beginning of the empirical inquiry that will be able to answer these questions.

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[12] Of the concepts of space noted in Figure 12.1, it appears that it is *physical space* that this literature implies in making the contrast of space and place. It remains to be seen where other concepts of space stand in this context.

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Part V
Psychiatric and Embodied View

Chapter 13
Affordances and Absence in Psychopathology

Joel Krueger

13.1 Introduction

Affordances are action-possibilities. They are ways of relating to and acting on our world. From the moment we wake up in the morning, we're constantly doing things: we check our phone, make coffee, get dressed, walk the dog, talk to people, take the subway, do our work, exercise, play games, go shopping, meditate, worship, and find ways to relax. We move through a world of affordances.

However, affordances are not just out there in the world. They are relative to the bodies who experience them. Different bodies perceive different sets of affordances; they inhabit different *niches*, as James Gibson refers to them. For an adult human, a chair affords sitting, standing on, or picking up. For infants, cats, lizards, and ladybugs, it affords none of these things—but it does afford crawling on or hiding under. Affordances emerge *relationally*, in the way these different bodies—with their unique structures, skills, habits, and histories—relate to the world. Affordances can help us understand how the same environment can mean different things to different animals. It can encompass different niches.

In this way, Gibson's theory of affordances is a theory of access. It helps us understand how we have bodily access to bits of the world and what it means to enjoy such access. But a question Gibson doesn't explicitly consider is what happens to bodies when this access is *ruptured* or *impeded*?

This question is relevant to psychopathology. Autistic people, for example, or people living with schizophrenia, clinical depression, obsessive-compulsive disorder, or anorexia nervosa often describe feeling as though they've lost access to bits of the world, to different affordances, that others take for granted. Some even describe feeling as though they inhabit a different world altogether. The way this

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experience develops, as well as its intensity and character, may differ from case to case. But most people find it disturbing and isolating. They feel cut off from the possibility of connecting with others and participating in a shared world of meaning.

As we'll see, thinking about the bodily consequences of losing access to everyday affordances can help us better understand these reports. An affordance-based approach can illuminate some of the causes, as well as the experiential character and content, of affective disorders in psychopathology. It can also draw attention to some underexplored ethical and political dimensions of these issues needing further consideration.

13.2 Affordances and Absence in Schizophrenia and Depression

Discussions of affordances often adopt a task-oriented perspective. They focus on how people, things, and spaces afford practical action. People afford shaking hands and talking; keyboards afford typing, chairs sitting, and hammers hammering; nightclubs afford dancing and bars drinking. And this is fine. Affordances play a key role in shaping how the world becomes present as a space of practical action.

However, this task-oriented focus can overlook the role affordances play in shaping our *affective* life. By "affective," I simply mean the rich array of moods, emotions, and other feelings that form the felt texture of our being-in-the-world. We don't just think and act. We feel things. And we construct niches that both reflect and regulate aspects of our affective lives at multiple timescales.

For example, if we are upset about something, we might seek the comfort of friends, wander through a familiar space (a favorite gallery, cafe, park, or worship space), binge-watch trash TV, slip into comfortable pajamas, drink Belgian beer, play computer games, do yoga, read poetry, listen to music, post a sad selfie on social media to get support from friends, or simply take a nap. Things and spaces—including online spaces (Krueger & Osler, 2019)—afford more than just practical actions. They afford *affect regulation*. We modify the world—specifically, the various niches that are part of it—to modify our affective life (Colombetti & Krueger, 2015).

How does this relate to psychopathology? Simply put, in conditions like schizophrenia and depression, individuals often lose access to regulative resources within everyday niches—and the stability of their affective life is compromised. Accordingly, if we try to understand affective disorders in psychiatric illness just by looking inside the individual (e.g., their neurobiology), we fail to capture the full causal complexity of the processes involved in shaping their disordered experience. Instead, we need to bring the world, including the affordances that are part of it, back into the story.

To see how so, let us revisit the notion of "access" and consider its connection with *trust*. Part of why our niches do the regulative work they do is because we

enjoy reliable access to them. We feel at home in them and therefore trust them. We trust our niches because we often set them up ourselves (e.g., our home or office). Other niches, such as a gym or public transport system, are set up by others. Nevertheless, we trust these niches, too, because we know what they *mean*, that is, what they afford and what it's appropriate to do (and not do) when we inhabit them.

But consider next how it feels when something goes wrong: our smartphone dies and the music abruptly stops in the middle of an intense workout; the Wi-Fi in our office building goes down and we feel powerless to work; a wheelchair lift we rely on is out of order; we're uncomfortable when approached by a distressed person speaking loudly and wearing dirty clothing; we hear a racist slur directed our way or feel a stranger's hand on our thigh while on the subway; we walk into a party and see a table of drinks that pulls on our hard-won sobriety.

In these cases, the world stops working the way we expect it to. We lose trust and feel disoriented. Even if it's only a brief experience, a mild sense of disorientation, this loss of trust arises because we are suddenly aware that some affordances we'd previously taken for granted are now missing. We experience these affordances as present *via their absence*.[1] And pieces of our affective life go with them. Without the motivation of our music, finishing a punishing workout suddenly feels like an impossible task. We are unable to joyfully lose ourselves in a book during our morning commute once our personal space has been threatened.

What I've described here are familiar everyday cases where our sense of reality "wobbles" (Ratcliffe, 2015) in some way and we lose trust in the world. Most of us regain this trust quickly enough as we adapt and move on. However, there are cases—such as schizophrenia and clinical depression—where this loss of trust is more global and persistent. In these cases, individuals no longer feel at home in a world they share with others. This is clear in how they describe their experience. Clinically depressed patients say things like "It is the glass wall that separates us from life, from ourselves, that is so truly frightening in depression...It is like living in a parallel universe" (Brampton, 2008, p. 171). We hear similar reports from people with schizophrenia: "I feel disconnected"; "A wall of void isolated me from everybody"; and "It is as if there were two worlds" (Stanghellini & Rosfort, 2013, p. 246).

Schizophrenia and depression are not the same thing, of course. But they do share some phenomenological similarities. For my purposes, what is interesting is that this feeling of being cut off from the world seems to flow from a disturbed sense of embodiment that impedes the individual's ability to affect, and be affected by, others and the world more generally (de Haan & Fuchs, 2010). Individuals with schizophrenia and depression often describe feeling as though they don't fit into their body the way others do; they feel alienated from their body and lack the ability to do things, respond to, and be affected by the world in a spontaneous way. Sometimes they even experience their body as an object that must be overcome to access the world.

[1] See Roberts and Krueger (2021) for more on the emotional experience of absence and loneliness.

These bodily disturbances change how individuals experience the niches they share with others, including the things and spaces that make up these niches. They experience various affordances as present *via their absence*. For example, some people with schizophrenia describe being drawn to the empty space surrounding people and things instead of the things themselves (Jaspers, 1963, p. 81). Others perceive objects as fragmented, flat, shifting, unrelated to one another, or distilled to pure geometric qualities that lack meaning (Silverstein et al., 2017). One person says "Everything around me is immobile. Things appear isolated, each one in itself, without suggesting anything. Certain things which ought to evoke memory, evoke an immense number of thoughts...remain isolated. They are more understood than experienced" (Minkowski, 1970, p. 276). These individuals are aware that their experience of the world and its affordances differs from others.

In depression, the world can be experienced as similarly inaccessible, as bodily out of reach: "You look at the world, the array of things that you could do and they're completely meaningless to you. They are as meaningless to you as if you were an earthworm" (Karp, 1996, p. 32). Echoing reports from people with schizophrenia, some people even describe feeling a global shift in how they experience the *meaning* of the world and things in it. This can mean that things no longer exert the affective pull one might expect: "Living with depression is like living in black and white when everyone else is living in color" (Benson et al., 2013, p. 73). But it can also suggest that the meaning of specific things, their affordances, has shifted—and subsequently, their regulative significance, too. Windows that once afforded looking through to savor the light and landscape now beckon relentlessly as a portal to a quick death; a fancy kitchen knife that previously summoned happy memories of shared meals and laughter now affords cutting human flesh and ending one's pain (Krueger & Colombetti, 2018).

The takeaway point is that in these cases, a disturbance of one's bodily relation to the world leads to a loss of trust—a sense that one no longer has access to the same niches, the same affordances, that others enjoy. Some affordances are experientially present via their absence. As a result, individuals no longer feel at home in the world. They feel disoriented, cut off from a shared world of interpersonal meaning. But part of this feeling arises from a loss of access to the material environment, too. When individuals lose access to regulative resources within their everyday niches—particularly in an enduring way, such as with schizophrenia and clinical depression—the stability and organization of their affective life is deeply compromised.

13.3 Affordances and Absence in Autism

As we've seen, affordances not only guide action. They regulate affect. Our niches do some of this work for us—often transparently, in the background—as we find our way through everyday life. They are set up to make us feel at home in them. But this is not the case for all niches. Some are set up to *deprive* certain people of access to

certain affordances. This might be deliberate; or it might not. Either way, it reminds us that our niches have ethical and political significance (Heras-Escribano, 2019; Crippen & Klement, 2020).

Critical phenomenologists like Sara Ahmed (2007) explore the bodily impact of inhabiting hostile niches configured to deliberately constrain certain bodies (e.g., queer bodies, severely ill or disabled bodies, non-white bodies) and their access to certain affordances. For example, Ahmed develops her phenomenology of "being stopped" to explore what it's like for non-white bodies, or those with "suspicious" (i.e., "terrorist sounding") names, to be stopped by the police more than other kinds of bodies. But this stopping can occur in other contexts, too, such as when non-white bodies are bombarded with racist images and memes online or passed over for a job promotion despite being equally well-qualified.

For Ahmed, this stopping doesn't just place practical constraints on stopped bodies. It has affective consequences, too. It induces a feeling of *disorientation*: a feeling that one's body is deeply out-of-sync with the world. This is because the threat of being stopped is pervasive, materially encoded in how some affordances (e.g., freedom of movement, access to certain spaces) are presented as accessible for some bodies but not others. Some affordances are experientially present via their absence. As a result, "[t]hose who get stopped are *moved in a different way*" as they find their way through the world (Ahmed, 2007, p. 162).

This perspective can help us understand the narratives of some people with autistic spectrum disorder (ASD). They describe feeling that to be an autistic person is the world is to be a stopped body (Krueger, 2021a, b). Often, autistic bodies are stopped from extending into and taking shape within the spaces they inhabit—niches designed to primarily accommodate how neurotypical bodies move, speak, act, and relate. This stopping leads to experiences of disorientation and a loss of trust. It involves an enduring feeling that one is not at home or welcome in these spaces.

From a neurotypical perspective, autistic people may have unusual styles of embodiment (Krueger, 2021a, b). The timing and flow of their movements can seem strange or inappropriate. They may have an unusual gait or posture or have tics and habits (hand-flapping, spinning, etc.) that are off-putting for people not accustomed to them. They may also repeatedly shrug, squint, pout, or rock back and forth; appear "stuck" in indecisive movements for a long time; turn away from social encounters; or repeatedly touch or handle a particular object.

Many people with ASD feel that their bodily style does not fit smoothly into neurotypical niches, even if they don't understand how or why this is so, exactly. This can be confusing and frustrating: "I have been endlessly criticized about how different I looked, criticized about all kinds of tiny differences in my behavior...no one ever tried to really understand what it was like to be me…" (Robledo et al., 2012, p. 6). What reports like this convey is that for many people with ASD, moving through neurotypical niches involves a perpetual anticipation of being stopped. They struggle to comfortably extend themselves into spaces organized around the form, and *norms*, of neurotypical bodies. Instead, they feel that the way they

experience and use their bodies is frowned upon when in these spaces (Krueger & Maiese, 2018).

For example, for many people with ASD, it is acceptable to avoid making eye contact when speaking with someone, take a long pause before responding (Leary & Donnellan, 2012), or provide direct answers to potentially sensitive questions ("Do I look good in this shirt?"; "No, you do not!") (Chapman, 2019, p. 430). But these practices are discouraged in neurotypical niches. The feeling of being stopped also applies to self-directed bodily practices of "self-stimulation" (or "self-stims")—hand-flapping, finger snapping, tapping objects, repetitive vocalizations, or rocking back and forth—that help people with ASD manage incoming sensory information and feel rooted in their bodies and the world. These things can confuse neurotypical people or make them uncomfortable. Treatment programs, often developed with little input from people with ASD, traditionally try to suppress or eliminate them.

The feeling of being stopped is not limited to face-to-face interactions. It also arises when dealing with the built environment. A noisy, brightly lit lecture hall, restaurant, or retail space, for instance, may negatively impact an individual with ASD's auditory and visual hypersensitivity in ways neurotypical bodies don't understand or appreciate. For people with ASD, the design of these spaces does not afford feeling at home. Instead, they are disorienting and bodily upsetting. As a result, possibilities for social connection and shared experience—beyond whatever practical actions these spaces afford—are experienced as bodily out of reach.

These observations indicate that some of the social difficulties people with ASD face aren't caused just by things going on inside their head (e.g., neurocognitive deficits, as is often assumed). Instead, they arise *relationally*, in the way that many everyday niches are not set up to be flexible and responsive to neurodivergent styles of embodiment and expression. These niches limit access to affordances that neurotypical bodies take for granted.

Accordingly, an affordance-based approach to ASD draws our attention to the role that bodily, interactive, *and* spatial features play in shaping social difficulties in ASD. And this is significant for intervention and treatment. It suggests that instead of trying to "fix" the heads of people with ASD (i.e., expecting them to conform to neurotypical styles of embodiment and thinking), we ought to instead construct niches that are more flexible and inclusive. For example, we should consider how things like colors, lights, textures, sounds, and smells may potentially disorient neurodivergent styles of embodiment and sensory processing and adjust our design approach accordingly. It also suggests that neurotypicals—and not just people with ASD—may benefit from social skills training. This may help them become more sensitive to and comfortable with neurodivergent ways of being in the world. By widening our perspective in the ways discussed above, an affordance-based approach equips us with some of the theoretical resources needed for this task.

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Chapter 14
Affordances and 3E Psychopathology

Kristopher Nielsen

14.1 Introduction

The intention of this essay is firstly to demonstrate that the concept of affordances is an extremely useful tool in the study of mental disorders. As part of this, I will overview a selection of recent works that apply the concept of affordances in interesting ways within analyses of psychopathology or of particular disorder concepts. Secondly, my intention is to suggest that there is a potential danger in the use of affordances within the study of mental disorder. As the concept of affordances itself shows us, any tool—tangible or conceptual—can constrain and direct our approach to a task. We cannot let such constraint blind us to the need for a plurality of approaches. The concept of affordances is a vital tool but must remain one tool among many when we are seeking to understand something as complex as mental disorder.

Breaking this essay down by section, I will first orient the reader to my own conceptual position of *3E Psychopathology*. This will allow the reader to understand the conceptual ground on which the essay stands and highlight the multi-scale complexity of these things we currently call mental disorders. In the second section, I will overview a selection of works that utilize the concept of affordances to richly describe and contribute to our understanding of mental disorders. I will also briefly describe how I use the concept of affordances in my therapeutic work as a clinical psychologist. Finally, in the third section, I will discuss the role that I can see for affordance-based thinking within a 3E-based science of psychopathology and the need for a plurality of approaches.

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14.2 3E Psychopathology

My particular approach to conceptualizing mental disorders is grounded in three principles concerning the nature of human functioning and *the mind*. These are the principles of embodiment, embedment, and enactivism—hence *3E Psychopathology*. These three principles have a rich history within philosophy of mind and the cognitive sciences that I do not have room to unpack here. Suffice to say that together they summarize a naturalistic and non-reductive conception of human functioning. This is a conception that holds the mind to be non-dualistic and dynamically constituted by the entire body rather than simply the brain (embodied), shaped by and deeply integrated with the physical and sociocultural environment (embedded), and, finally, geared for action and deeply concerned with *meaning*, which emerges from the needful relationship between the precarious organism and their environment (enactive). For more on this conception of human functioning, see Thompson (2007). Note that I do not incorporate ideas of extension/4E cognition due to concerns regarding a tension between such ideas and the bodily focus of embodiment/enactivism, a worry that ideas of extension move too far from everyday language, and a belief that a principle of embeddedness can achieve much the same ends. For full explanation of this, see Nielsen (2020).

From this 3E perspective, and considering the evidence that the causes of mental disorder are best seen as *dappled* across the brain, body, and environment (Kendler, 2012), I have proposed that mental disorders are best seen as dynamic and reafferent patterns that exist across the brain-body-environment system, keeping people stuck in behaviors that do not ultimately serve their own needs and purposes (Nielsen, 2020). Such patterns constitute a disruption to the embodied *sense-making* processes of the individual, a conclusion also supported by other authors in the area (de Haan, 2020; Maiese, 2021)—although my view is somewhat more mechanistically oriented (Nielsen, 2021). On this view, the *disorder* or *dysfunction* present is not one of a *part* not performing its function, nor of a societal-level judgment that a behavior is abnormal or wrong, but instead an evaluation that someone is repetitively and inflexibly acting against their own best interests at the cost of their *faring well* in life (Maiese, 2021; Nielsen & Ward, 2020a). From this perspective, it makes sense that mental disorders such as "depression" do not look exactly the same across individuals. Instead they can be defined by the similarity of the overall patterns observed across individuals.

If we are to better understand and explain mental disorders from this 3E perspective, then *one* important way to do so will be to seek to perceive the constituent phenomena within these psychopathological patterns at multiple scales of inquiry (e.g., what does the phenomenon of *hypervigilance* in PTSD look like at the scale of the genetic, physiological, neurological, behavioral, experiential, and interpersonal). Situated in this richer understanding, we could then hypothesize about how these phenomena relate to each other and thus how the wider pattern manages to hang together and maintain within a person's experience and behavior, despite the

fact that it is negatively impacting them (Nielsen & Ward, 2020b). One further way that we may seek to better understand mental disorder from this view is to consider an individual's "mode of functioning." How, within their particular sociocultural niche, have they learnt to survive and thrive in the world, and what has changed so that this mode of functioning is no longer working for them (Nielsen, 2020)? This second approach to explanation is geared more toward understanding the emergence of these psychopathological patterns within individuals rather than why these patterns maintain at a nomothetic ("across-people") level.

Under both of these approaches to explaining mental disorder from a 3E perspective, it is necessary to understand the experiences of those stuck in pattern of distress. This is because, from the principle of enactivism, human beings (and all creatures) live lives perfused with meaning, and this meaning shapes our behavior. To borrow a term from Colombetti (2014), there is a *primordial affectivity* to our experience (and all life). We perceive the world not from an objective standpoint, but from a position of concern. The meaning we enact is immediate in our experience of the world and is a vital component of understanding behavior. For example, when someone with arachnophobia spots a potential spider, fear literally ripples through their whole body, re-orienting attention and preparing the body for perceived threat, all due to what a spider *means* for them. If we are to understand the complex and often seemingly baffling behavior observed in mental disorder, we must then understand the meaning at play. Thomas Fuchs, a researcher and psychiatrist who has played a key role in the extension of enactive ideas to the study and conception of psychopathology, even goes so far as to say that "phenomenology may…be considered the foundational science for psychopathology" (Fuchs, 2010). This then brings us to the role of affordances.

Similar to the original definition offered by Gibson (1977), *from an enactive perspective, affordances can be thought of as "meanings for action*." As creatures built to act, when we make sense of an object or situation in the world, we perceive those opportunities for action that accord with our particular bodies, capacities, habits, and current intentions. As with all meaning, from an enactive perspective, affordances are seen as *relational* (Thompson, 2007). They pertain to the relationship between the embodied organism and the environment rather than being simple facts about that environment. The concept of affordances then is one that allows us to break down and better understand the immanent meaning for action present in someone's experience of the world. If mental disorders are indeed disruptions in an individual's ways of making sense of and responding to the world—as proposed by the emerging 3E perspective—then the concept of affordances is clearly going to be a useful conceptual tool for their study.

14.3 The Utility of Affordances for Understanding Mental Disorders

In order to demonstrate the utility of affordance-based thinking for understanding mental disorders, this section will briefly summarize a selection of works that have developed the concept of affordances for this purpose and for modelling particular disorder concepts. As a note, for reasons of space, it is not my intention to engage with these works critically. I will then make a brief comment on the utility of affordance-based thinking in a therapeutic context based on my own experience.

De Haan et al. (2013) present the idea of a *field of affordances*: that selection of affordances that an individual is responsive to in a particular situation. This field is conceptualized along three dimensions, those of width, depth, and height. *Width* refers to the range of different affordances an individual is responsive to, *depth* refers to the temporal awareness of how affordances are likely to shift with time and our own action, and *height* refers to the salience of different action possibilities. These authors go on to example how this allows for consideration of different mental disorders. They example that depression can be understood as a flattening of the field of affordances in height (i.e., a reduction in motivation/salience of possibilities for action), a narrowing in width (i.e., a reduction in flexibility/the perception of different action possibilities), and a shrinking in depth (i.e., a reduction in future orientation to action possibilities). They also discuss how obsessive-compulsive disorder, the focus of their analysis, can be understood as the dominance of compulsive actions within their field of affordances. The compulsive action(s) are of high affective salience, demand completion before other actions can be completed, and obscure the perception of other action possibilities—thus keeping people stuck in repetitive action.

Within a wider discussion of what mental disorder looks like from an embodied, embedded, and enactive worldview, Maiese (2021) has recently discussed the role of affordances in the normative constitution of mental disorder. Across different contexts in life, she points out that it is necessary for us to enact different roles/modes of functioning so as to stay attuned to the needs of that context. Maiese refers to these different modes as *regional identities*. Each regional identity is seen as a different collection of interrelated habits/sensorimotor schemes, partially constituted by the differential saliences of affordances across contexts, so as to allow good functional fit with the requirements of the kind of situation that the regional identity was developed for. For example, a different field of affordances will present themselves to a doctor entering a hospital when they enter as a doctor, as a patient, or as a support person for their friend. Incorporating this idea, Maiese proposes that mental disorders in general often concern the deregulated enaction of these regional identities, thus producing *dis-attunement* with the sense-making of the individual and the needs of their context. Such a *dis-attunement of sense-making* appears to be referring to and building on the idea of functional fit between an organism's pattern of engagement and their environment, i.e., whether a behavior is working for the organism (Nielsen & Ward, 2020a). Maiese's use of language such as *identity* and

selves is a potential source of confusion here and potentially invites tension with the principle of embodiment—i.e., is Julie-the-engineer really a different person to Julie-the-mother? However, her wider point about the need to attune our sense-making to our particular context—even at the unconscious level of the salience of particular affordances—and the role this can play in psychopathology is a fascinating and useful one.

Another interesting and recent use of affordances in the study of mental disorder comes from Krueger and Colombetti (2018). These authors build on notions of *affective affordances* and *affective niche construction*. They make the observation that in normal life, it is common for people to regulate their affective state by constructing an environment that scaffolds their emotions, thus supporting mood regulation. As examples, we carry lucky charms, we listen to different kinds of music to evoke sought-after emotional states, we may seek out friends when we are sad, and we decorate different rooms to evoke mood states that are fit for the room's purpose. Considering depression and schizophrenia in particular, these authors begin with noting the alterations in the field of affordances described by sufferers of these conditions that play a role in continuing distress. Very briefly summarizing, depression is described as a general flattening out of the field of affordances in terms of salience/motivation, with those affordances that do break through as salient often having a negative impact on mood and well-being. For example, observing as salient possibilities for sleep, continued inaction, self-harm, or suicide. Schizophrenia is described as a dysregulation of the salience of affective affordances/felt meaning, resulting in an experience of *un-worlding* or alienation. These authors also discuss fascinating differences in how sufferers of these conditions often experience their own body, but I do not have room to discuss this here. One of Krueger and Colombetti's most useful observations, however, is in reference to the *bidirectional* relationship between a person experiencing mental disorder and their environment. They describe how depressed individuals often appear to construct affective niches that reinforce their depressed mood state. Due to their depressed mood state and the effect of this on their field of affordances, individuals may keep curtains shut, not bother to buy nutritious and enjoyable food, reduce engagement with friends and exercise, etc. In those with schizophrenia, the authors describe how perceptual abnormalities can be seen to disrupt the field of affordances to the point that the world is perceived as significantly less coherent and becomes alienating or even threatening, and thereby behavior becomes disorganized. While Krueger and Colombetti do not mention this specifically, it is interesting to consider here how the behaviors facilitated by this perception of the world (e.g., talking to one's self or looking at people with suspicion) often evoke distrust and the expression of suspicion from others, again forming a potential positive feedback loop. In summary, Krueger and Colombetti's analysis suggests that when studying mental disorders through an affordance-based lens, we should not only consider the nature of the affordances that those suffering from disorder perceive. Rather, we must also consider the affordances that people generate for themselves over time and how this can play a role in perpetuating the dynamic circular patterns of distress and dysfunction that constitute mental disorder.

There are likely many further examples of the utility of affordance-based thinking for the study of mental disorders. We can briefly consider the "collapse" of the field of affordances in substance dependency, where behavioral possibilities associated with gaining access to the relevant substance likely appear with great saliency and other affordances important for daily living fade into the background. Similarly, in anorexia nervosa, we might speculate about the likely altered affordances provided by food items and by the body. However, given the cross-disciplinary and scholastic intentions of this collection of essays, I thought it may be of greater interest to briefly consider how I have personally found affordance-based thinking to be useful in a related but more practical task: that of therapy.

When working in a psychotherapeutic context, one of the key tasks is to help a client understand their own presenting problem. Moreover, this task has practical intentions—to help the client identify areas within their experience where they may have more control than they realize. In a sense, we can think of therapy as collaborative sense-making about the client's own sense-making processes. Connected to this, drawing a client's attention to the affordances salient to them at any given moment can often be a helpful maneuver. If I as a therapist invite a client to take note of what their environment affords them and how their field of affordances changes in a dynamic way—that often accords with their emotional state—this can be one route to begin to structure greater affective awareness and agency.

A clinical example that comes to mind includes a man experiencing attacks of unexplained anger during a period of stress. Through consideration of the affordances salient to him during these attacks, we were able to recognize that what he was experiencing were actually panic attacks—a relatively normal phenomenon—masked by the fact that he had never learned to recognize and label fear. Recognizing this reduced feelings of confusion and anger, allowing us to develop some fitting coping strategies, and the attacks consequently stopped. Another example would be a young woman experiencing PTSD following sexual assault. Through learning to observe that, in her state of hypervigilance, every male of the street afforded scanning and evaluation for threat, she was able to observe that constantly following this afforded action only exacerbated her sense of stress and fear over time. Recognizing and labelling this affordance allowed her to accept that this behavior made sense in light of her past experience but also highlighted that she had more power over her fear than she realized. By learning to more explicitly consider the affordances salient to them, clients gain greater opportunity to *choose* their actions and disrupt habits that may be helping to hold them in distress. They may also with time gain greater awareness that certain actions have the capacity to alter, or reinforce, their current emotional/mood state. I wish to stress that these are nothing but my own observations as a relatively novice therapist, but I thought it may be of interest to the reader to consider how affordance-based thinking can be useful for considering and coming to understand mental disorders—not just in a scientific sense but in an experiential and first-personal sense.

14.4 One Tool Among Many

Hopefully I have by now sufficiently demonstrated how affordance-based thinking has significant utility for the study and understanding of mental disorders. Through evoking a sense of empathy, allowing us to imagine the embodied experience of someone stuck in a pattern of mental disorder, models grounded in notions of affordance seem to evoke a deep sense of understanding. In other words, they often appear to make mental disorders "make sense." However, I want to also highlight that there is a potential danger in this sense of understanding. Somewhat ironically, affordance-based thinking is the perfect tool to help us understand this. When we hold a hammer in our hands, our affordance space is constrained by the tool we hold and many objects around us take on a hittable quality, decreasing the salience of other action possibilities. In the same way, use of a particular method of analysis—such as affordance-based thinking—can constrain our theoretical and investigative possibilities.

Our reason for wanting to understand mental disorders in the first place is primarily to afford us power over them: to reveal handholds that will allow us to develop better treatments and alleviate suffering. Following assumptions of embodiment and embedment, we must recognize that mental disorders are multi-scale and constitutionally complex things. Understanding experience and the role of affordances in perpetuating distress is absolutely necessary—and it is also not enough. We must also seek to understand the constitutional structure of mental disorders—what they look like at multiple scales of inquiry and from multiple points of view. To put it another way, we need to ask further questions about how these alterations in experience and a person's field of affordances are situated in a social and physical context and how they are constituted within the body. Such a goal demands a plurality of methods and indeed a plurality of conceptual approaches. Affordance-based thinking is a fascinating and useful tool for studying mental disorders, but it must remain one tool in the psychopathologist's toolbox.

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Part VI
Experiential and Interactive View

Chapter 15
Studying Embodied Decisions in the Wild and in the Lab

Jeremy Gordon, Gian Luca Lancia, Mattia Eluchans, Antonella Maselli, Thomas Thiery, Paul Cisek, and Giovanni Pezzulo

15.1 Introduction

When we think about decisions in our own lives, we usually have in mind a process of selection between a limited set of clear-cut offers, such as a choice between our favorite restaurants, available venues to host an event, or different goods to buy online. These economic choices have received significant attention in economics, psychology, and neuroeconomics (Glimcher & Rustichini, 2004; Padoa-Schioppa, 2011; Rangel et al., 2008), but an overemphasis on this subset of decision-making

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may have imparted a false optimism that our decision models are fully mature and our understanding of these processes nearly complete.

On the contrary, there is another important class of decisions, likely even more common than their economic counterparts, which exhibit tremendous complexity and for which our understanding and ability to develop computational models is still in its infancy. This class is what we call *embodied decisions* which have mostly been overlooked by rigorous investigation to date (Cisek & Pastor-Bernier, 2014; Lepora & Pezzulo, 2015; Yoo et al., 2021). Embodied decisions involve the continuous selection between present affordances (e.g., different routes to take in traffic) as well as future affordances that we create, or destroy, by acting (e.g., by selecting a certain route, we close off opportunities to select alternative routes later on). Embodied decisions were key for adaptive behavior in our evolutionary ancestors, and their neural mechanisms have been conserved for hundreds of millions of years (Rodríguez et al., 2002; Saitoh et al., 2007; Striedter & Northcutt, 2019), providing the context for the more modern innovations of neural circuitry in mammals and primates (Cisek, 2019; Passingham & Wise, 2012). Embodied decisions still remain pervasive in our daily lives. Navigating as pedestrians or drivers, organizing items on our desk, and playing sports with friends are, for many of us, familiar activities requiring numerous embodied decisions to successfully complete.

Embodied choices differ from economic choices in a number of fundamental ways: they present living organisms with unique challenges and require different conceptualizations (and perhaps also recruit distinct brain circuits). For example, classical economic decisions are typically decomposed into sequential phases (Fodor, 1983; Pylyshyn, 1984): perception of salient attributes, decision between alternatives, and reporting of the final decision by action (i.e., *decide-then-act*). However, this decomposition does not work well in the embodied paradigm, where perception, decision, and action processes are recurrent and intertwined. Consider, for example, the case of a driver who is deciding whether or not to overtake another car. To make this decision, the driver might continuously seek potential (*overtake-ability*) affordances created by the left or right movements of the other car. By adjusting her own relative road position (e.g., moving to the center), she may exhibit what Eleanor Gibson calls *prospectivity*, in which future overtakeability affordances are created via anticipatory action (Gibson, 1997). Furthermore, the decision itself is temporally extended rather than instantaneous: after beginning to overtake, the driver may accelerate more aggressively or even abort her plan and brake if she spots a car in the opposite direction. As this example shows, embodied decisions are hardly separable into different phases: they are continuous and often imply situations in which decision-makers utilize action as a constituent of the decision-making process, continuously reconsider affordances and action outcomes, and can change their mind along the way (Cisek & Pastor-Bernier, 2014; Lepora & Pezzulo, 2015; Yoo et al., 2021). Furthermore, this example shows that in embodied decisions, action components are much more prominent than in classical settings, in which actions are simply ways to report an already formed decision, rather than part and parcel of it. More broadly, not just action components but embodied and situated aspects become more crucial. As we will describe, most embodied decisions can be

cast in terms of the selection between affordances, which are by definition relational entities, as they depend on brain-body-environment relationships and interactions (Beer, 1995; Borghi, 2004; Costantini et al., 2011; Gibson, 1979; Nolfi, 2011; Pezzulo et al., 2010).

Another key difference between economic and embodied decisions is that while the latter are classically constructed as choices between a small fixed number of offers (in many studies, just two) that are pre-specified by the experimenter, this is rarely the case during embodied decisions. In the latter, the number of alternatives for the deliberative process (e.g., the alternative paths to be considered when driving) is not fixed. Rather, possible trajectories, and the decision landscape (or affordance landscape) within which they are embedded, are dynamical and change continuously, influenced by the environment as well as by the actions of the decision-maker (Pezzulo & Cisek, 2016).

15.2 Novel Questions Raised by Embodied Decisions and How to Address Them

These and other unique features of embodied decisions raise exciting new questions. For example, how do we perceive affordances and how does affordance perception guide our decision processes? What are the key choice dimensions that guide the selection between action alternatives or affordances? Are the dimensions of embodied choices largely stable across contexts (e.g., driving, walking, playing basketball) or predominantly context-dependent? How do people estimate these choice dimensions (and also the relevant potential alternatives that enter the deliberation) under the significant uncertainty associated with sensorimotor settings? How do people deliberate between present and future affordances? What are the neuronal circuits that are especially relevant in embodied choice processes? How do perceptual, decision, and action processes deploy during embodied decisions, how do they influence each other, and to what extent can they be separated?

Some studies have begun to address these challenges. For example, it is becoming increasingly common to use devices that track continuous (eye, hand, or mouse) movements during screen-based choice tasks, for example, to explore how decision and action processes influence each other (Barca & Pezzulo, 2015; Burk et al., 2014; Cos et al., 2021; Marcos et al., 2015; Michalski et al., 2020; Resulaj et al., 2009; Spivey, 2007; Spivey et al., 2005; Spivey & Dale, 2006). Figure 15.1 illustrates the richness of (finger) movement kinematics that an example participant executes while solving a spatial navigation task. The task is similar to the *traveling salesman* problem and requires finding a path that starts from the yellow dot and passes through all the red dots, without crossing any node twice (Eluchans et al., in preparation). The nine panels of Fig. 15.1 show the time course of the finger kinematics (in blue) and of the selected path (highlighted in gray) as a single participant solved a sample problem. The density of the blue circles that form the finger

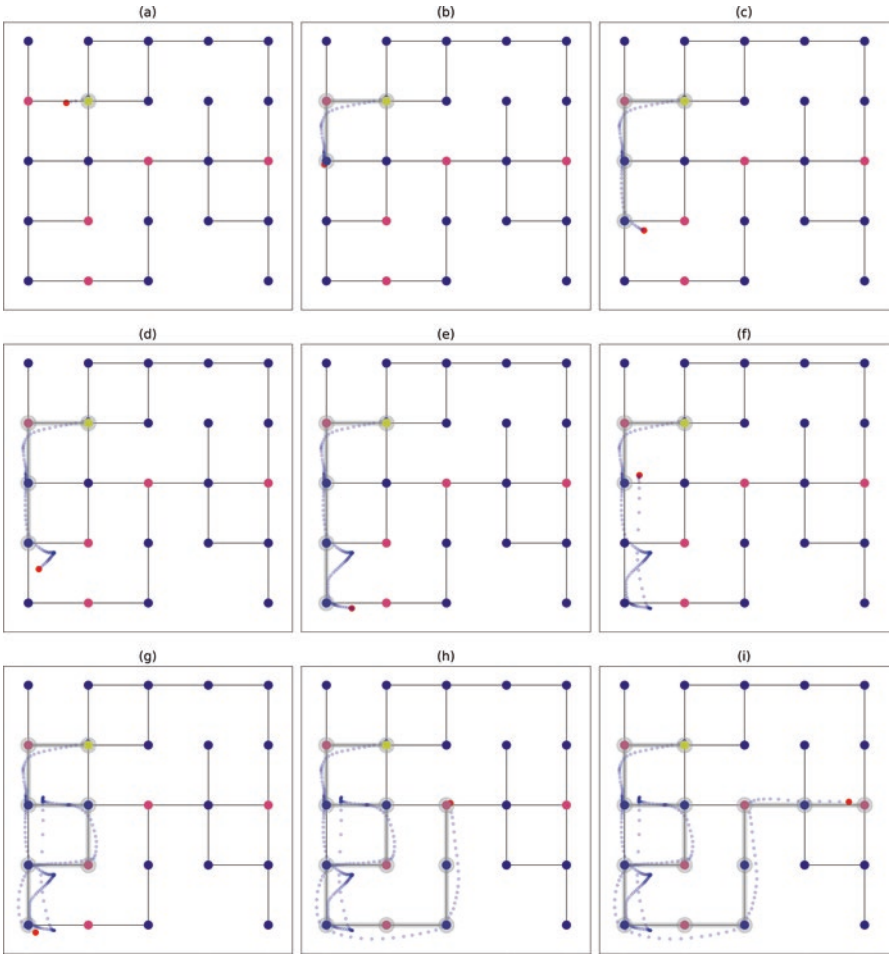

Fig. 15.1 Tracking finger movements during a problem-solving task, similar to the traveling salesman. The nine panels show the time course of the finger movements of an example participant during a task requiring finding a path from the start node (yellow dot) and passing through all the red dots, without crossing any dot twice. The finger trajectory is shown with small blue circles (whose density indexes movement velocity), and the currently selected path is highlighted in gray. See the main text for explanation.

trajectory illustrates the finger velocity, with greater density indicating slower finger movements. Initially, the participant moves fast to the left (Fig. 15.1a) and then down, before pausing (Fig. 15.1b). Afterward, she continues to move down and starts moving right (Fig. 15.1c); but before completing the right movement, she "changes her mind" and moves down instead (Fig. 15.1d). After briefly moving to the right (Fig. 15.1e), she *backtracks* and undoes a large portion of the path (Fig. 15.1f). The last three panels of Figure 1 show how, afterward, she finds a path that solves the problem. This example illustrates that tracking movements during a

cognitive task (here, spatial problem-solving) provides rich kinematic data, such as movement direction and velocity, pauses, and changes of direction. These in turn can shed light on the dynamics of cognitive processes, such as the plan under consideration and its associated confidence, choice uncertainty, and changes of mind.

Furthermore, there is a recent trend of studying more naturalistic settings in systems neuroscience, for example, with neural recordings in freely moving animals (Chestek et al., 2009; Schwarz et al., 2014; Sodagar et al., 2007) or during navigation in controlled environments (Etienne et al., 2014; Krumin et al., 2018). Notably, some recent studies have found good ways to overcome some of the methodological challenges that arise when recording human neural activity during ecological situations, such as the presence of noise generated by movements. For example, recent technical innovations have made it possible to record neural activity while humans walk with a portable iEEG system in their backpacks (Aghajan et al., 2017; Topalovic et al., 2020). New noninvasive recording systems are also becoming more popular, including new MEG sensors (SQUID) that can be directly attached on the scalp and produce less movement-related artifacts (Boto et al., 2018). Finally, studies using a combination of electroencephalography and virtual reality provide unprecedented ways to study how humans process affordances in ecological settings (Djebbara et al., 2019, 2021).

However, many interesting facets of embodied decisions still remain unaddressed, partly due to conceptual and methodological difficulties. Perhaps the most fundamental methodological challenge is the formalization, measurement, and experimental manipulation of affordance-related choice dimensions, such as the *overtakeability* for car drivers, *passability* of balls for basketball or soccer players, or *jumpability* for river crossers who must navigate from stone to stone. These choice dimensions reflect geometric, physical, and embodied aspects of the situation, such as, for the example of crossing a river, the distances between stones, the size and abilities of the person, and the surface attributes of the landing sites. It is often unclear how to select, define, and factor these dimensions in a decision model.

We will illustrate a generic methodology to formalize embodied choice settings *in the lab*, in terms of an *expected value* surface, which is analogous to the key notion of expected value in neuroeconomic studies; see Gordon et al. (2021) for a more detailed treatment. In neuroeconomics, expected value is defined as the mathematical expectation of the utility (U), treated as a random variable across all possible outcomes: $EV = \mathrm{E}(\mathrm{U}) = \sum_i \mathrm{P}(U_i) \cdot U_i$. By projecting this definition onto a physical 2D space where i indexes all possible locations—what we call the expected value surface—we combine these same two factors, *probabilities* and *utilities*, in a way that extends naturally to many embodied decision settings. Further, the components of our expected value surface take on the new semantics of immediate affordances (capturing present opportunities for movement) and future affordances (capturing the approximate downstream utility of occupying a particular location), respectively. Some of these ideas have been developed to address embodied decisions *in the wild*, namely, for the analytics of sports like basketball (Cervone et al., 2016) and soccer (Fernández et al., 2019). These studies can model a multiplicity of choice factors using a data-driven approach (e.g., recordings from hundreds or

thousands of games) that is not possible in lab studies. We show that it is, however, feasible to apply similar principles to smaller-scale studies *in the lab*, for which a simpler formal characterization is possible—as in the case of the *crossing-the-river* task that we discuss below.

15.3 An Annotated Example of Embodied Choice "in the Lab": Crossing the River

Imagine a person who has to cross a river by jumping between stones of different sizes and placed at different spatial locations (see Fig. 15.2). Using the affordance landscape decomposition strategy mentioned above, and an intuitive physical knowledge of the dynamics of jumping to targets in a high-risk setting, we can model the problem as follows. Immediate affordances are composed of two subcomponents, one representing the jumper's range given their present location (Fig. 15.2b) and the other representing the stones affording (dry) *landability* in the environment (Fig. 15.2c). In contrast, the utility landscape (Fig. 15.2d) must incorporate the goal-directedness of the task, which we approximate as a simple linear distance to the goal location (the opposite bank of the river).

Consistent with our mapping from the economic decision setting, we compute the expected value landscape as the product of probability and utility as shown in Fig. 15.2e. The resultant surface summarizes the best places in the environment to be, conditioned on the goal of crossing the river, and subject to the constraints of the embodied present. As can be readily seen, the small stone to the northeast provides the maximum expected value as it is near enough to jump to easily and affords forward progress.

However, this example also highlights a problem. If our jumper perceives and acts on the expected value surface shown in Fig. 15.2e, they will find themselves in a dead end since all subsequent jumps fall on the peripheries of their range. This can be seen in the new immediate affordance landscapes after taking action *right* as shown in Fig. 15.3a. The solution, of course, lies in planning. To the extent that the affordance landscapes visualized in this example correspond to a dynamics model capturing the interactions of the individual and their environment, then this model can also be used to evaluate hypothetical multi-step action sequences (i.e., mental simulation or *rollouts* in the Reinforcement Learning literature). While simulation of a single step, e.g., $A_0 = right$, results in an updated EV surface with low maximum value, $A_0 = left$ (a jump to the slightly less direct option to the left) results in a much better situation.

As is common in planning agents, we can model deliberation at each jump by generating multiple rollouts guided by a Monte Carlo (stochastic) trajectory sampling algorithm which generates plausible trajectories through the expected value surface itself. As with REINFORCE (Sutton & Barto, 1998) or ATS (Maisto et al., 2021), we can then update the action policy conditioned on the resultant discounted

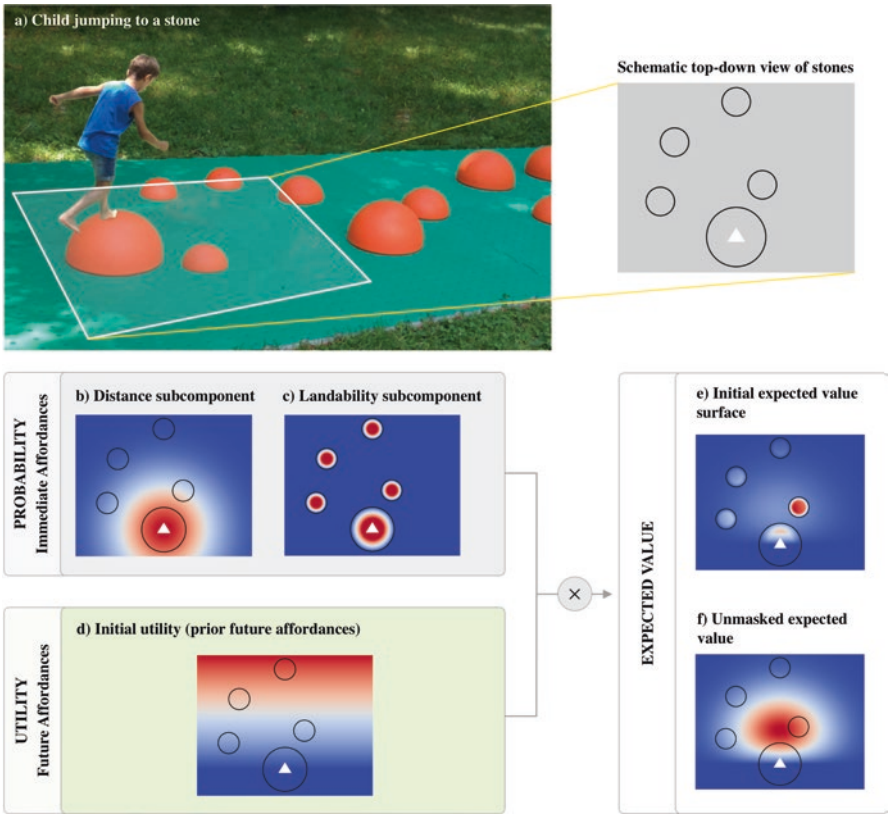

Fig. 15.2 An example embodied decision. (**a**) While *crossing a river*, a child (whose position is indicated by the white triangle) has to decide which stones to jump to next. (**b–f**) The choice situation can be decomposed by considering the two fundamental dimensions of probability (capturing the roles of immediate affordances) and utility (capturing the roles of future affordances) of the choices, which can be combined to calculate an *expected value* surface—and which peaks at the best stone. In turn, the probability dimension can be further decomposed into a distance subcomponent (that prioritizes closer stones) and a landability subcomponent (that prioritizes bigger stones), each of which can be quantified mathematically, based on considerations of the physical, geometric, and embodied characteristics of the setup (e.g., distance reflects the physical body-object distance that may be scaled by body size). Note that, in this example, the utility subcomponent is naïve as it only prioritizes stones that are physically closer to the destination, without also considering whether they are closer or farther from other stones (see Fig. 15.2 for this additional constraint). See Gordon et al. (2021) for further details

expected value at each step along the trajectory. The result, as shown in Figs. 15.3b and c, is an updated value surface favoring the future-aware utility of the left stone, over the greedy immediate access to the right.

This toy example highlights the way we might model the simplest decision point during a navigation episode. One might further expand this example to consider additional dimensions that are usually studied in economic decision settings, such

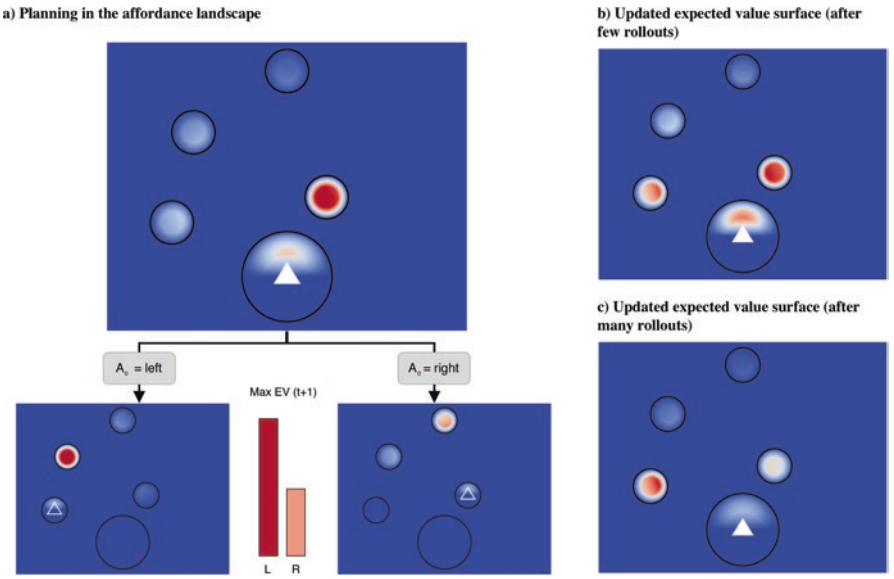

Fig 15.3 Planning while crossing the river. (**a**) Expected value surface without planning and, below, the expected result for the actions left and right. (**b–c**) Expected value surfaces after one-step planning. The cost of computing these updates is a function of parameters specific to both the planner (e.g., learning rate, planning depth) and problem context (e.g., number and differentiation of offers available, branching factor, etc.). Here, we show two updated utility surfaces, calculated using two rollouts (**b**) or ten rollouts (**c**) of a Monte Carlo trajectory sampling algorithm. Note that these are cartoon examples, as the result depends on the choice of parameters such as learning rate

as the influence of *decoys* or intertemporal considerations in the choice process. Additionally, this case of crossing the river raises several other considerations that might constrain or influence the decision process of an agent performing the task. These include epistemic value and, more broadly, information-theoretic considerations, which are often more nuanced in embodied settings like our example.

As pointed out by Rubin et al., information-theoretic measures and the circular nature of information flow between agent and environment are rarely considered in methods such as REINFORCE or ATS mentioned above—and, more broadly, in problems formulated as Markov decision processes (MDPs) (Rubin et al., 2012). Studies in humans have shown that experts, in particular, effectively leverage information embedded in environment-agent interaction (e.g., by taking epistemic actions) to reduce the complexity of a task and the cognitive resources required to solve it (Kirsh & Maglio, 1994). Furthermore, decision-makers often trade off the accuracy of a decision and its complexity, by selecting (for example) plans that are less effective or less accurate but simpler to form and follow, hence saving cognitive resources (Bhui et al., 2021; Zénon et al., 2019).

In our task, agents may exploit the structure of the environment to reduce the complexity of not only present but also future decisions. As shown in Fig. 15.4a, imagine an agent deciding between two paths across the river, one more direct path

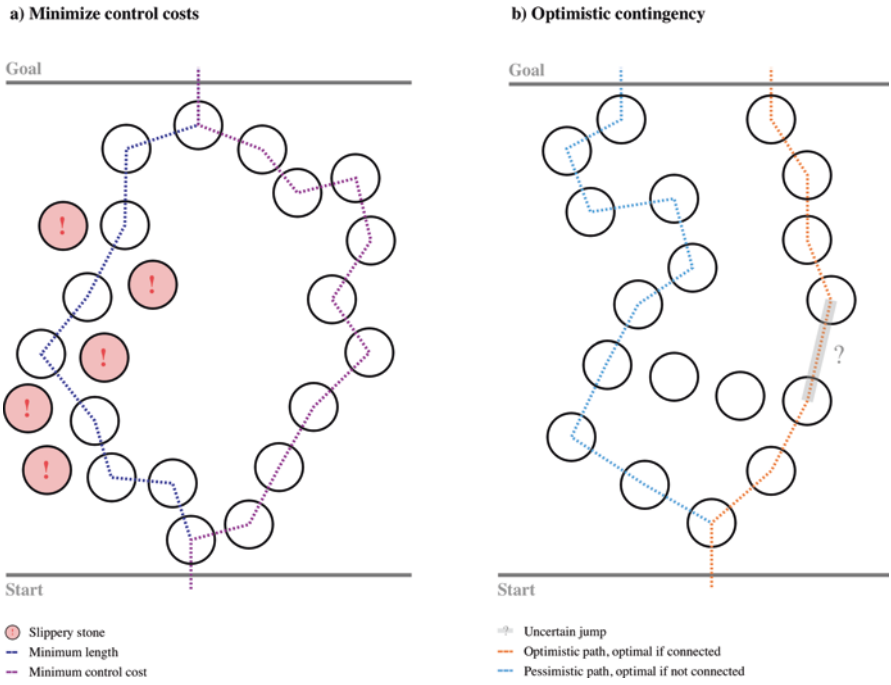

Fig. 15.4 Examples of information-theoretic considerations studied in the context of the crossing-the-river task. (**a**) In a configuration where some stones are *slippery*, the magenta path minimizes control costs by reducing the complexity of expected future decisions, despite its greater length. (**b**) The uncertainty inherent to the task (due to partial observability and the probabilistic nature of the affordance landscape) can result in scenarios where epistemic value must be considered. A visit to the stone prior to the uncertain jump (gray question mark) may reveal that it is passable, permitting continuation on the optimal orange route, or impassable, requiring the agent to fall back on a detour to the less direct blue route

(blue) that passes through a field of *slippery* stones, which must be avoided, and a less direct path (magenta) that can be successfully navigated with a trivial control policy (e.g., "jump to the nearest stone that I haven't already visited"). While the blue path minimizes jumps and distance, it depends on the deployment of either a continuing perceptual evaluation process (detect and avoid slippery stones) or the memorization of a safe route, which must be stored in working memory. In contrast, the magenta path enables the agent to *offload* these considerations, thus exploiting the information held in the environment.

Our cross-the-river task also enables the study of other behaviors inherent to real decisions in naturalistic settings such as contingency planning, in which downstream decisions must be considered in the context of multiple possible configurations that have not yet been observed. Recent work has studied human navigation behavior in this context, finding that participants choose to sample information in proportion to the expected cost of an undesirable contingency (Ma et al., 2021). In Fig. 15.4b, we imagine a river configuration exhibiting uncertainty in passability

(and therefore in the true affordances available to the agent during crossing). Prior to entering the river, the feasibility of the jump on the right, highlighted by the gray bar, may be ambiguous. If passable, the orange route will minimize distance, but if not, the blue route is optimal. Owing to the partial observability inherent to embodied decision settings, certainty about the critical jump is expected to evolve as the agent approaches, and by doing so, it obtains an improved estimate of the gap with respect to its own jump range. Some agents may prefer to pursue the rightmost route optimistically, knowing that a suitable alternative is available (the middle stones connecting to the blue path) contingent on discovering the uncertain jump is in fact too far. Crucially, to the extent that (as shown before) we are able to mathematically characterize the decision variables, such as present and future affordances, we are also able to provide a rigorous formal account of different strategies (e.g., optimistic strategies or those that minimize control costs) and compare them with human behavior. As these examples illustrate, embodied decision tasks provide a rich setting to study both classical economic decisions and embodied and situated aspects of decision-making that are rarely considered but fundamental to understanding how we make ecologically valid choices. The development of novel formal approaches to study embodied decisions might pave the way to the development of novel research programs that address more directly how we continuously select, exploit, and create present and future affordances (Gordon et al., 2021).

15.4 Conclusion

We began by noting that research on decision-making (e.g., in psychology and neuroeconomics) has historically focused on classical economic settings where participants weigh the monetary value of a limited number of offers. We noted that human evolutionary history was certainly dominated by a far more complex class of decisions, in which movement plays a driving role, and offers change dynamically through a temporally extended process. Despite challenges in studying these more naturalistic embodied decision settings, novel methods are already being explored enabling studies both in the wild (e.g., during soccer or basketball games or during animal foraging) and in the lab (e.g., in reduced laboratory versions of the above settings that expose similar embodied choice dynamics). We presented a general framework to study the construction of expected value landscapes by mapping the classical notions of probability and utility as immediate and future affordances. We then illustrated this method with the case of crossing the river and highlighted some of the planning-based and information-theoretic considerations it allows us to reason about. We believe studies and models of this nature may help advance research into decision-making by bringing insights from the more naturalistic sensorimotor problems we are confronted with every day.

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Chapter 16
Toward Human Augmentation Using Neural Fingerprints of Affordances

Lukas Gehrke, Pedro Lopes, and Klaus Gramann

16.1 Introduction

To describe the inseparable connection of action and perception, Gibson introduced the term affordance in his 1979 seminal work on the ecological approach to perception (Gibson, 2014). According to Gibson, affordances are possibilities for action that a given environment, object, or interactive technology offers a person or user. In other words, what actions can we perform with the things surrounding us. For example, a chair affords sitting on or a door handle affords grasping and pushing it down.

The application of the affordance concept is a *key* topic in usability and user experience design. Objects and interfaces are well-designed when they "suggest how to be used" (Gibson, 2014). Don Norman picked up this definition of affordances in *The Design of Everyday Things* (Norman, 2013), complementing the basic psychological research of Gibson with practical application. By re-framing affordances from a designer's viewpoint, Norman motivated designers to implement Gibson's theories and put the objective to design for easily perceived utility at the core of his definition of *user-centered design*.

Placing the user at the center of the design process requires a thorough consideration of the user's physical constitution. The emphasis on the holistic physical constitution has been apparent in contemporary extension of Gibson's original definition of affordance. Clark defined affordances as "the possibilities for use, intervention, and action which the physical world offers a given agent and are determined by the

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'fit' between the agent's physical structure, capacities, and skills and the action-related properties of the environment itself" (Clark, 1999). In this view, affordance emerges in the interplay between object and user. For example, through visual, haptic, and proprioceptive relations between a cup and the user emerges the affordance of grasping and picking it up. Another example is that of a child and a children's chair, where the affordance of sitting emerges while the same small chair might not afford an adult person to sit on it. Chemero (2018) has argued that affordances are in fact best defined as such relations emerging in interactions (Chemero, 2018).

Crucially then, designers should consider all *communication* channels that allow a user to interact with the designed artifact. By communication channels, we refer to all sensory modalities in which the user has a relation with the object they want to interact with.

16.1.1 Interfacing Affordances for Human Augmentation

In our increasingly complex world, many objects in our environment do not readily afford their intended use case. For example, we frequently find objects to require multi-step interaction, such as a spray can that needs to be shaken before use (Lopes et al., 2015). Today, the challenge is to design such a shake-before-use affordance. But how can we establish a relation that communicates this dynamic use?

Frequently, the intended behavioral changes or dynamic uses of objects are communicated through instruction manuals or displays on the object itself, for example, a red sign on a door when locked. However, the affordance to grasp the door handle would still emerge as the handle remains visible, decreasing the interaction efficiency. To avoid this, consider a *smart* shape-changing door. Economidou and Hengeveld (2021) demonstrated a shape-changing door prototype using actuators and laser-cut polygonal wood elements, elegantly bridging the digital to the physical environment. To cue entry prohibition, the door changed its shaped and concealed its panel. Hence, their prototype attenuated the emergence of a grasp-door-handle affordance by altering the perception-action relations between the physical object and the user.

But animating *smart* physical objects comes at a cost, such as a high engineering/construction effort with significant hardware costs. Due to the hardware's constant configuration changes during operation, the high cost is also represented in energy consumption. Further, changing a user's environment may be a surprising experience impacting interaction efficiency (Follmer et al., 2013). With inFORM, Follmer et al. (2013) explored a shape-changing display and found that "rapid shape transitions were jarring to users" (Follmer et al., 2013), concluding that caution must be taken in the design of transitions to not confuse users.

As an alternative route, designers may choose to impinge (an affordance) on the user more immediately. This would be possible by inducing an action in the user that indicates the required interaction with the object. Such an approach requires the use of a haptic device with sufficient force to induce movements in the user. The

most traditional way to achieve this is by pushing the user's body or parts of the body with a mechanical force. To this end, motor-based haptic systems like exoskeletons and mechanical devices with sensors and actuators that are placed on the users' body to support and augment movements can be used (e.g., Sandoval-Gonzalez et al., 2016). However, these devices tend to be large and cumbersome and as such tend to find more applications in factory settings than in everyday situations (Nith et al., 2021). To circumvent this size limitation of existing motor-based haptic devices, researchers have turned to electrically stimulating the user's muscles with a small and safe current applied via electrodes attached to the user's skin (Lopes & Baudisch, 2013; Tamaki et al., 2011). For instance, in Affordance++, Lopes et al. (2015) used electric muscle stimulation (EMS) on the user's forearm to communicate the multi-step process such as shaking a spray can before using it. When users picked up the can, muscles on the forearm were electrically stimulated to trigger a shaking movement in the wrist, indicating the dynamic use of shaking the can before spraying. Instead of augmenting the object, Lopes et al. (2015) augmented the user, arguing that "While animating objects allows implementing object behavior, we argue affordance is about implementing user behavior" (Lopes et al., 2015).

However, these approaches are still simplistic in that they assume the user's mental state and physical predispositions are static—in fact, these approaches currently assume the user is ready to receive the physical assistance at any time and will not ever be disrupted by it: an unrealistic assumption. With respect to the above example of shaking the spray can, once the shake-can-before-use affordance emerged, the muscle stimulation is redundant. If the users pick up the can a second time, they know that the can affords shaking before spraying. However, the can is not aware of what's going on in the user's mind and thus cannot adapt to a user who learned that the can should be shook before use when picking it up again.

But how can the system be made aware of the user's understanding of the object? How can it be informed about the user's side of the affordance, the user's "[...] physical structure, capacities, and skills [...]" (Clark, 1999)? Or in more general terms, how can a system be made aware of the users' current action plan?

We propose that more information on the user's current state is needed to fully realize the potential of these new types of affordances. We instantiate this by measuring the electrical activity of the user's brain through the electroencephalogram (EEG) to establish a direct communication channel between the users' brain and the "smart" computing layer of the objects in their environment. In our research, we aim at elucidating how to leverage the user's mental state(s) to *moderate the emergence of affordances* through actuating hardware such as exoskeletons or EMS. We believe the simultaneous use of brain measurements and physical actuation of the user's body allows to test whether *implementing affordances* is possible. This approach holds particular promise for physically challenged users as well as going beyond the human bodies' physical limitations.

16.1.2 Related Work

For our proposal to work, brain activity must carry information in terms of affordances. Following Gibson's *ecological psychology*, affordances are the *direct* perception of action possibilities. The key idea is that perception and action are inseparable.

Such an inseparable relation between action and perception is reflected in the organization of the primate brain that reveals a close interaction of cortical structures underlying visual information processing and motor control (Gallese et al., 1996). Different processing streams in the human brain subserve the processing of semantic perceptual object information in the ventral stream and object-directed action information in the dorsal stream (Mishkin et al., 1983). Faster processing of incoming visual information in the dorsal stream allows for quick relaying of action-relevant information to the premotor and motor cortices for the selection of adequate action programs (Nowak & Bullier, 1997).

As a consequence, passively perceiving objects that afford interaction activates motor areas, which are also active when the interaction is executed. This has been demonstrated in a study showing participants' images varying in their level of implied affordance, contrasting faces, animals, and houses with images of tools. Scanning the participants' brain when looking at the images of tools revealed activity known to occur during the use of one's hand (Chao & Martin, 2000). The observed brain areas reported in the study are related to the execution of a grasping or reaching movement as well as attributing such movements to the self. Hence, merely looking at the images of tools triggered a brain response similar to the actual use of the tools even though no action was possible as participants were instructed to lie still in the brain scanner.

Similar studies have shown that this brain activity decreases when affordances vanish. These studies typically manipulate (1) an object's location and/or (2) an object's visual features. The manipulation of the object's location means placing it either in peripersonal space where one could grab it or in extrapersonal space where one cannot. On the other hand, the visual features are altered from familiar forms, such as a cup, to distorted unfamiliar variants. It is frequently reported that brain activity congruent to the physical grasping action is also measurable when participants are merely looking at an expected graspable object in peripersonal space. Importantly, this brain activity pattern disappears with changes in form or distance (Wamain et al., 2016). Wamain et al. (2016) found the μ rhythm of EEG activity, an oscillation around 10 Hz that originates in motor areas, to diminish gradually as an object was moved from peripersonal to extrapersonal space. Importantly, this was only observed for objects with a familiar form. As it appears, the fast communication between visual areas and motor regions allows for affordances to influence action-related brain activity.

Hence, the brain activity underlying this perception-action is moderated by the *fit* between us and our environment, as described in Clark's definition of affordances. Crucially, the communication between perception and action-relevant brain

structures is bidirectional, and activity in early sensory pathways is also moderated by the afforded interactions and the intentions of the user (Goslin et al., 2012). Planned actions can tune the neural populations underlying visual (and potentially also of other senses) perception of the environment (Job et al., 2017), again indicating an inseparable perception-action relationship.

Given this tight action-perception coupling and the accompanying brain activity, the neural representation of affordance can be measured using neurophysiological methods. This does not necessarily imply that the recorded activity reflects affordance in absolute terms, but rather affordance as embedded in the user's mental model of the potential interaction with an object. For example, it could be that an object affords several actions, like the spray can that affords shaking as well as pushing the button to spray. Thus, the push-button-to-spray affordance might be the *dominating* affordance, while shaking-can-before-use is not. However, the user has the knowledge to shake the can, but this might have been masked by the push-button-to-spray affordance as the latter is more closely related to the action goal (e.g., painting a surface).

16.2 A System for Human Augmentation: Leveraging EEG and Physical Actuators

We imagine an interactive system consisting of two components: (1) the measurement of human brain activity by means of EEG and other physiological sensors, for example, electromyography (EMG) to capture neuromotor activity, and (2) a haptic device capable of moving the user's body, for example, the aforementioned exoskeletons or EMS; see Fig. 16.1.

We investigate how EEG and EMG can be used to infer whether an affordance emerges and the user intends to act or not. Subsequently, through physical actuation of the user's body, for example, lifting a finger to cue a reaching movement, the system can manipulate affordance, either motivating or discouraging an upcoming action.

This hinges on a fast capture of information originating from the perception-action coupling in the brain. Djebbara et al. (2019) have captured "neural fingerprints of affordances" already 200 ms after the onset of a visual stimulus. In their work, participants were placed in VR scenes with three differently sized doors, some of them were designed to afford passage, while others were not. EEG capture of motor-related brain activity differed when participants saw a door they were physically able to pass as compared to a door that was too narrow to fit through. This very early response would allow human action augmentation, i.e., to initiate or inhibit motor execution already after 200 ms, discouraging walking toward the door by, for example, gait manipulation.

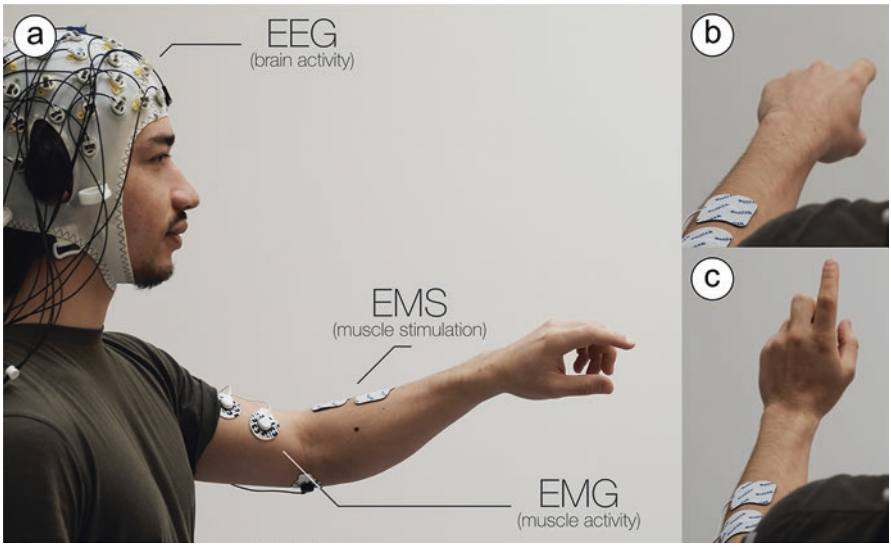

Fig. 16.1 (**a**) Participant wearing a system with 64-channel EEG, 1-channel EMG, and 1-channel EMS on the left forearm (Gehrke, 2022). See Gehrke et al. (2019, 2022) for more detail on a comparable setup. (**b**) Relaxed hand/finger position preceding an afforded tapping interaction. (**c**) We propose a system that actuates the user's forearm muscles by detecting the user's mental state, such as an intention to execute a tapping movement, and cues the user's movement through EMS. When the forearm muscles are activated through EMS, the user's hand and finger are lifted, and the tapping affordance is communicated

16.2.1 Implications: Extending Affordances

For illustration purposes, we discuss the application of such a human-machine system on the two *sides* of the affordance relation—the object side and the user side.

First, extending "the possibilities for use, intervention, and action with the physical world" (Clark, 1999) focuses more on the *object side*. Following Lopes et al. (2015), the system can indicate affordances that are not readily available by actuating the user's physical structure, as in the example of shaking the spray can. If the system detects brain activity corresponding to a grasp affordance, it can check in with the current state of the spray can (push vs. shake necessary). If perceived affordance and current state of the can do not align, the actuating hardware can step into the interaction to adapt it. This is especially promising considering the ubiquitous Internet of Things (IoT), where *smart* objects are in constant connection with the user and their environment. IoT objects are frequently equipped with many sensors that enable them to adapt their behavior to the user's state. Assuming these objects have access to the user's mental states (e.g., through EEG measurements), the required action by the object and the action intended by the user can be inspected for alignment. In the case of detected discrepancies, the actuating hardware can impinge the interaction behavior of the user toward the required action, for example, discouraging the user to shake the spray can in case it is empty by applying force

against the shaking movement. This illustrates the neuroadaptive capacities in case of multiple-use options where rigid mental models attenuate existing alternatives for use that are not easily perceived by the user. Second, moderating "...the 'fit' between the agent's physical structure, capacities, and skills and the action-related properties of the environment itself" focuses on the *user side*. Here, one interesting implication is whether affordances can be extended using such a proposed augmentation system. Consider a heavy stone lying somewhere in the user's peripersonal space. While it is in distance where they could pick it up, and its shape would allow holding it, its appearance indicates that it is likely too heavy to do so. Monitoring the user's brain activity will indicate that no fingerprint of the affordance to pick up the stone is present. However, through the help of an exoskeleton, it could indeed be possible for the augmented user to lift the said stone. The system, through monitoring the user's muscle activity, has access to the user's physical capabilities. By modeling the day-to-day arm lifting activities, the system learns the limits of the user's arm strength. Then, when an object's weight, like the stones, supersedes the user's arm strength, the system may nudge the user's arms to try and lift the stone and assist the user in lifting it. Over time the affordance may be extended with the system being able to constantly check whether changes in the brain activity reflect an affordance fingerprint. While enabling such superhuman capacities is an interesting research direction, application in settings where precise motor control is required, such as during creative expression (Scott & Gehrke, 2019), promises similar returns.

16.3 Conclusion

We proposed the idea to leverage EEG in conjunction with force-feedback haptic devices to allow objects in our surroundings to exhibit dynamic affordances. In other words, not only users can be instrumented (with a haptic device, such as a force-feedback or exoskeleton device) to learn how to best manipulate an object they encounter, but the user can *also* be instrumented with a sensing device (such as EEG) that allows the interactive system to fine-tune the affordance according to the user's mental state. Such a system critically depends on the fast measurement of brain activity to cue, moderate, and control a user's body movement via actuation hardware in near real time. With our closing thoughts, we hope to stimulate a debate about the design of systems for physically augmented humans.

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Chapter 17
A Husserlian Approach to Affectivity and Temporality in Affordance Perception

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17.1 Introduction

Famously, J. J. Gibson (1977/2017) coined the term affordance to refer to the action possibilities offered to a given animal by the environment. However, he also claimed that, even if affordances are always perceived from the perspective of individual animals, their existence is fully independent of those who perceive them. The rejection of the idea that affordances are animal-dependent comes from Gibson's dissatisfaction towards the subjective-objective dichotomies present in the psychological theories of his time—theories that still today play a central role in the cognitive sciences. In contrast, the concept of affordance was supposed to cut across all possible forms of dualism and, as we understand it, be the starting point for a new relational ontology. However, the characterization of the notion of affordance has been often found obscure and has generated some confusion even among the most enthusiastic ecological psychologists. As a matter of fact, despite the anti-Cartesian and non-dualistic tendencies shared among all Gibsonian scholars, the ontological debate behind the same notion of affordance includes several proposals. It has been discussed whether affordances should be better defined as environmental resources (Reed, 1996), as dispositional properties (Turvey, 1992), or as relations between abilities of the animal and aspects of the situation (Chemero, 2003, 2009). In this paper, we are not aiming to provide either a fine-grained taxonomy of the different proposals (however, see Rucińska, 2020) or an extensive discussion of the points of

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strength and weakness of each individual ontological stance. What seems problematic is that, on the one hand, if affordances are thought of as nothing but physical properties, it is unclear in which sense they must be understood in reference to a certain animal. On the other hand, if affordances are to be understood in reference to an animal, it is unclear in which sense they are not animal-dependent. These ambiguities have led some neo-Gibsonians to think of affordances as latent properties existing independently of individual organisms or whole species (e.g. Fultot et al., 2016; Heras-Escribano, 2019). However, as Di Paolo noticed, assuming a God's eye view and claiming that affordances can exist even if there would be no extant species is something that can be claimed only hindsight and represents a dramatic universal disembodied statement (Di Paolo, 2016). Reasonably, this same assumption seems to contradict Gibson's idea of an irreducible mutuality between organisms and environment.

As most 4E theorists, we recognize the value of the notion of affordance. However, in this paper, we aim to provide a phenomenological characterization of the perceiver's role in affordance perception. We believe that such a phenomenological approach is pivotal for the understanding of affordances. More precisely, we argue that proper phenomenological descriptions can provide important insights into how perceivers participate and contribute to the emergence of affordances. What is distinctive of the phenomenological tradition is the interest in the essential a priori structures and structural invariants of experience. If affordances are understood as phenomena that cut across "the dichotomy between subjectivity and objectivity", it spontaneously follows that their existence depends on environmental features as much as on the active role of situated subjects whose experience can be described phenomenologically.[1] If our proposal is right, and thus phenomenological analyses can enrich our understanding of affordance perception, particular attention is to be paid to the affective and temporal characteristics of the phenomenology of experiencing an affordance. More specifically, we look at these phenomena as characterized in the work of Edmund Husserl. While the claim that phenomenological investigations can contribute to our understanding of the nature of affordances is something that has been discussed in the past (see Käufer & Chemero, 2021; Dings,

[1] It should be acknowledged that there might be some tension between phenomenology and ecological psychology insofar as the former (especially in its Husserlian version) is explicitly anti-naturalist, whereas the latter "rejects the causal reductionism of other scientific psychologies but without rejecting their emphasis on experiment and empirical explanation" (Reed, 1996, p. 19). It would go beyond the scope of this paper to delve into Husserl's anti-naturalism and the possibility of integrating phenomenology and ecological psychology. Suffice it to say that, from a Husserlian standpoint, consciousness should be seen as a condition for the natural world to appear, and thus, it would be a category mistake to study consciousness from the perspective of the natural sciences for they assume that the objects they study are *in* the natural world. We believe, however, that a non-objectivist scientific approach to the mind (such as ecological psychology) and/or a re-conceptualization of the idea of *nature* could be consistent with phenomenology's anti-naturalism. For a brief suggestion on how ecological psychology and Husserlian phenomenology could be integrated, see Roy et al. (1999, pp. 68–71). For more on the idea of re-thinking the concept of *nature* and thus opening the possibility of integrating a new kind of naturalism and phenomenology, see Vörös (2014) and Gallagher (2018).

2018), to our knowledge, the phenomenological aspects of temporality and affectivity have been so far largely unexplored by affordance theorists.[2] Importantly, in the current work, we sympathize with the relational approach developed by Chemero (2009). By considering affordances as emergent relations in which both the animal and its surroundings are constitutively necessary for the existence of affordances, his approach can fully embrace the considerations made by Husserl in which phenomena such as temporality and affectivity are necessary for the phenomenological appearance of the functional character of everyday objects. We are also aware that our proposal represents a departure from Gibson's original ideas in which ecological information is exclusively contained in the environment as something that "need only to be attended to" (Gibson, 1972, p. 79). Our considerations instead resonate with the notion of ecological information as developed by van Dijk et al. (2015). The notion of information here discussed, that the authors define as *information-how*, is not independent of its usage, and it is maintained through the activities of a community of agents through their histories of interaction.

17.2 Affordances: Beyond Objectivity and Subjectivity

The experience of a climber who is in front of a climbing wall can, without hesitation, be used as an example to elucidate the value that phenomenological analyses can play regarding affordance perception.

As anyone who has gone to an indoor climbing centre knows, a climbing wall has several holds that have different shapes, sizes, and textures. For a climber, such holds appear, to a greater or lesser extent, as graspable—they *afford* being grasped. For instance, whereas a curvy-shaped hold that has a *pocket* in which the climber's hand could fit appears as graspable, a sharp-edged and smooth hold may appear less so (Fig. 17.1). In other words, the holds are perceived as graspable, and this is possible exactly in virtue of the relation between a subject and a specific object.

While most orthodox ecological psychologists would simply claim that the hold is perceived as graspable because it matches a bodily disposition of the perceiver (Turvey, 1992), we suggest that there is much more to be learnt if the experience of *graspability* is phenomenologically analysed. In the first place, through phenomenological descriptions, it is possible to further emphasize how the affordance of grasping is fully inherent to the perception of the hold. The perceptual meaning of the hold is in part constituted by what it affords. The hold is perceived as affording the action of grasping as part of its perceptual meaning. Importantly, affordances are, in a very specific sense, irreducible and genuinely given in pre-reflective experience. The climber does not have to think about whether a hold is graspable or not;

[2] To be sure, affection and temporality are not the only phenomenological characteristics that underpin affordance perception. One should also acknowledge, among other things, the experience of one's own embodiment, the sedimentation of habits or attunement towards daily sociocultural practices. However, we will focus on affection and temporality alone.

Fig. 17.1 Climbing holds. The left-side hold, as it has a shape in which a person's hand naturally fits, may appear as graspable. The right-side hold, because of its shape and texture, may appear as less graspable than the left-side hold

it just appears as so. Thus, to better understand the role that the subject plays, it is important to look into the phenomenology of affordance perception.[3]

It could be objected that our phenomenological emphasis might lead to thinking of affordances as completely subject-dependent. For instance, Heras-Escribano has claimed that "the main problem of the phenomenological approach is that it focuses on subjectivity; hence, phenomenologists endorse the subjective-objective dichotomy that is inconsistent with the ecological approach and the nature of affordances" (2019, p. 105). However, it is important to emphasize that, from a phenomenological characterization, it does not follow that action possibilities are just a mere projection or a private affair of the perceivers. Phenomenology, as a philosophical method, is not aimed at grasping a private and inaccessible mental domain in which the subject is trapped inside. The phenomenological method is instead concerned with the rigorous study of the invariants that are essential to different experiences. Therefore, a phenomenological analysis of affordance perception does not aim to disclose a private mental domain, but a set of structures that are essential to such a kind of experience. It follows that the emphasis on first-person analyses that

[3] The relevance of a phenomenological analysis of affordance perception has already been pointed out by Dreyfus and Kelly (2007), as well as other authors inspired by them. However, most (if not all) those phenomenological approaches to affordance perception have usually drawn to Merleau-Pontian phenomenology, rather than from Husserlian phenomenology as we do.

characterizes phenomenological investigations can be seen as a valid complementation to ecological descriptions. Furthermore, phenomenologists would agree with Gibson in claiming that affordances are both objective and subjective. They are *objective* in the sense that they are aspects and features of the objects perceived in the world. However, they are also *subjective* in the sense that they only make sense as appearing from the perspective of an animal. Thus, from our phenomenological standpoint, Gibson's words are confirmed: "an affordance is neither an objective property nor a subjective property; *or it is both if you like*" (1979/2015, p. 121, emphasis added).

At this point, a Gibsonian may object that by suggesting that, from a phenomenological perspective, affordances can be understood as both subjective and objective, we are ignoring the fact that the theory of affordances is meant to show the inadequacy of the subjective-objective dichotomy. For instance, Gibson claims that "the absolute duality of 'objective' and 'subjective' is false. When we consider the affordances of things, we escape this philosophical dichotomy" (1979/2015, p. 35). In a word, affordances point towards the unity of the organism-environment system and not towards a distinction between a subjective organism and an objective environment. Therefore, it would be a mistake to describe an affordance as either subjective or objective as we have done. However, we believe that our phenomenological approach does not subscribe to a traditional dichotomy between subject and object. By arguing that affordances are *both* subjective and objective, we claim that an *absolute duality* (as Gibson calls it) between those two poles is untenable. Moreover, a phenomenological analysis like ours is well-fitted to address the experiential dimension of affordance perception without dividing the so-called organism-environment system. As phenomenologists often suggest, a careful analysis of experience reveals an essential correlation between consciousness and world.[4] The phenomenology of affordance perception is a great example of how subjectivity and objectivity are always correlated. Our proposal consists precisely in claiming that, phenomenologically, this dual—or perhaps ambiguous—nature of affordances can be appreciated by analysing the affective and temporal characteristics of affordance perception. We now turn to them.

[4] Our phenomenological approach to affordance perception needs thus to be differentiated from the idea that perceivers project or construct a subjectiveenvironment. Instead, we think of agents as actively disclosing their meaningful surroundings. This difference can be furtherly highlighted by comparing ourproposal with the contemporary approaches in biosemiotics that stemmed from the work of Jakob von Uexküll. For him, as much as for his followers (e.g. Kull etal., 2011), agents, through the receptors of their physiological apparatuses, literally create their niches. As von Uexküll puts it, "So in the nervous system thestimulus itself does not really appear but its place is taken by an entirely different process which has nothing to do with events in the outside world. [...] Thestimuli of the outside world are altogether translated into a nervous sign language" (1909/1996, p. 33). As it should be clear at this point, we reject thisconstructivist view in favour of a relational approach to affordances.

17.3 Affection and Temporality as Preconditions for Affordance Perception

As the climber is standing in front of the climbing wall, some of the holds appear more inviting than others. Indeed, depending on its shape and texture, the distances between it and the climber, and even the climber's skill and embodiment, a hold may seem somewhat more (or somewhat less) alluring in contrast to other holds. This allure is what Husserl calls *affection*:

> By affection we understand allure given to consciousness, the peculiar pull that an object given to consciousness exercises on the ego; it is a pull that is relaxed when the ego turns toward it attentively, and progresses from here, striving toward self-giving intuition, disclosing more and more of the self of the object, thus, striving toward an acquisition of knowledge, toward a more precise view of the object. (2001, p. 196)

Importantly, an object does not affect in isolation. It always affects from within a background. Think about a red dot in the middle of a white canvas. The red dot is alluring because of the stark contrast between it and the white background. If, instead of being on a white canvas, the red dot was in the middle of one of Pollock's artworks, it would not be as salient precisely because of a lack of strong contrast.

Husserl limits his analyses of affection to the purely sensory domain, but it can be smoothly extended to world-involving and meaningful activities.[5] From the perspective of the climber, all the holds in the climbing wall are affective to a lesser or a greater extent, but some of them are more alluring precisely because of the contrast of how grabbable they appear. So, for instance, if the two holds that appear in Fig. 17.1 were right beside one another roughly at the same distance from the climber's location, the curvy-shaped hold would probably appear to the climber as more alluring than the sharp-edged one. Importantly, based on the situation, the inviting character of the two holds can drastically vary in such a way that one can prevail over the other. Thus, one might say that one hold has more affective power than the other one.

What does it mean to say that an object is alluring (i.e. affective)? For Husserl, it simply means that it draws the attention of the subject (in the case of the example, the climber). However, it is possible to highlight that there are different ways in which an object may draw one's attention. For instance, the red dot in the middle of the red canvas draws attention by motivating the observer to look at it. In contrast, the curvy-shaped hold draws attention by motivating the climber to grasp it. Notably, both ways of drawing a subject's attention involve an affordance: the red dot is *look-able* and the hold is graspable. In general, objects draw our attention by motivating

[5] A similar take on the role on affectivity has been embraced in empirical psychology by Frijda (2004) and Lambie (2020), among others.

us to practically engage with them in different ways.[6] Therefore, affection is affordance-related, and meaningful affordances are affective.[7]

What is interesting about the affective nature of affordances is that, from a phenomenological perspective, affection is a felt *pull* coming from what is affecting the agent. It is not something that can be understood as an intracranial phenomenon or something that the subject projects onto the environment. Rather, affection is experienced as a centripetal force—assuming the subject as a metaphorical centre of curvature—in between the affected subject and the affecting object that can only arise given the physical properties of the latter and its surroundings and the fact of there being a subject who can interact with the affecting object. Indeed, the red dot affects the way it does partly because of its colour and the contrast between it and the white background. The curvy-shaped hold affects the way it does partly because of its shape and because of the contrast with other surrounding holds. In other words, part of the affective nature of affordances must be understood in reference to the physical properties of the objects and their surroundings. Thus, there is something irreducibly *objective* (in the sense of, object-dependent) about the phenomenology of affordances.

Affordances, however, are not entirely *objective* in the sense just described. As mentioned, their affective nature is in between what is objective and subjective. From the side of the perceiver, a crucial role for an affordance to emerge and be detected as meaningful is related to the temporal dynamics intrinsic to experience. Briefly, Husserl (1991) described the experience of time as constituted by three intertwined intentions: *retention*, *primal impression*, and *protention*. Put simply, at any given moment, one is not only aware via primal impression of what is happening in the current instant, but one is also pre-reflectively aware of what just happened via retention and what is about to happen via protention. At any given moment, one is simultaneously conscious of the just-past, the immediate present, and the near future. In other words, one does not have an experience of a "knife-edge" present but of a "duration block" which Husserl dubs *the living present*.[8]

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[6] This can be related to Dreyfus and Kelly (2007), who anticipated that, when manifesting, affordances are perceived as *solicitations*. We suggest that, while more than one affordance can have an *inviting character*, the subject will tend towards one specific action possibility depending on their affective force.

[7] Here *affectivity* is understood in relation to the possibility of being affected, i.e. to be allured or to undergo a stimulus ("*Reiz*" in German). This sense of affectivity might seem very different from the one related to *affective states* such as emotions or moods. We believe, however, that both senses are intrinsically related. For instance, something disgusting may draw one's attention because of how disgusting it is. Furthermore, Husserl (2006, Nrs. 69–75) himself suggests that affection may be defined by feelings of pleasure or displeasure (*lust* and *unlust*) that motivate the ego to react in different ways. In a few words, both senses of *affectivity* are connected by the idea that something can only affect if there is a lack of indifference towards it (Colombetti, 2014). A full-fledged phenomenological analysis of affordances would have to say much more about the affective nature of affordances.

[8] There are several subtle and complex relations between retention, primal impression, and protention which constitute the living present. It is, however, impossible to develop this topic further in this paper. See Husserl (1991, 2001).

What is relevant about the structure of time consciousness is that one is always aware of the near future. There are several ways in which protention constitutes one's experience of the world. For instance, while listening to a melody, even for the first time, one already pre-reflectively anticipates vague ways in which it might continue. Or, for a more relevant example, when the climber sees the climbing wall in front of her, she already pre-reflectively anticipates vague ways in which certain holds can be efficiently grabbed. In other words, the hold affords grasping because it is experienced as being potentially grabbed in the future. It is not only that the physical properties of the hold constitute part of its *graspability* but also the fact that the climber protends such grabbing. Such protention is like a centrifugal force that connects the embodied subject with the object. Without there being such anticipatory dynamics within experience, affordances would not emerge from the perspective of the subject. What we want to emphasize here is that the conscious temporal dynamics that are intrinsic to every experience play a central role in our understanding of how affordances are unfolded in the phenomenology of any individual agent.

Interestingly, it is under the correlation between the centrifugal and centripetal aspects of affordance perception that it becomes evident that affordances cannot be reduced to either purely objective or purely subjective properties. This fact becomes particularly salient in an example that is less artificial than that of wall climbing. Take the different experiences of a rock climber who goes to the same mountain at two different times of the year: summer and winter (Fig. 17.2). The two experiences are very different from one another insofar as different affordances appear for the

Fig. 17.2 Rock climbing. The same environment may afford different action possibilities insofar as it is in constant flux. The same rock wall may affect a rock climber in a specific way during summer (left) which is very different from how it might affect him during winter (right)

rock climber. Indeed, even though in a sense the rock wall is the same in both experiences, it affects in two radically different ways, entailing two radically different ways of anticipating possible paths for the rock climber. Thus, changes in the environment entail changes in how the field of affordances is experienced. Correlatively, changes in the rock climber also entail changes in how she experiences the field of affordances. Perhaps she has climbed the same wall in the past; perhaps she just saw somebody else climbing the wall; or even, there might have been an increase in her muscular weight. These changes entail different anticipations, different affordances that become salient from the perspective of the rock climber. Thus, affordance perception emerges from the interplay between how the environment affects the subject and how the subject anticipates possible ways of acting on the environment.

17.4 Conclusion

In this brief paper, we have emphasized how phenomenological analyses can support Gibson's formulation of affordances as being simultaneously *objective* and *subjective*. We drew on Husserl's analyses of affectivity and temporality to provide a more fine-grained understanding of the role of the subject in affordance perception. Our discussion seems to suggest that affordances involve both centripetal and centrifugal aspects. Affordances are centripetal because of the characteristics of the objects perceived that make it possible for an object to affect the subject. However, affordances are also centrifugal because of the protentional intention coming from the agent. Taken together, both the phenomena of temporality and affectivity show strong synergies with the notion of affordance as originally conceived.

Importantly, it will never be emphasized enough that, if not misconstrued as a mere form of introspection, phenomenological methods can provide an understanding of *subjectivity* in line with Gibson's strong commitment to anti-Cartesianism. From this phenomenological perspective, *subjectivity* is to be understood as a situated subjectivity that refers to a subject that is essentially related to the world, which, in turn, is essentially related to the subject. Thus, subjectivity, from a phenomenological perspective, is not some kind of pure interiority that might project a phenomenal world from within, but rather it connotes the perspective of a subject that is *within* the world. On the one hand, pure ecological descriptions are extremely relevant to provide descriptions of an environment that is pragmatically meaningful for the subject. Despite the scepticism of most ecological psychologists towards first-person reports, we are convinced that the two traditions can be seen as complementary to each other.[9]

[9]We would like to thank two anonymous reviewers for their comments on an earlier version of this paper.

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Part VII
Engineering and Computational View

Chapter 18
Easy as 1, 2, 3: On the Short History of the Use of Affordance in Active Inference

Maxwell J. D. Ramstead

18.1 Introduction

The theme of this collection of essays is the construct of affordances, originally developed in ecological psychology (Gibson, 1966, 1979), but which now extends far beyond it—as evinced by the contributions to this collection. Indeed, by now, it is safe to say that affordances have become part of mainstream science. The concept of affordances seems to pop up everywhere, from philosophy and the social sciences to the neurosciences, from design and user experience to architecture. The concept has become particularly important in the context of emergent technologies, especially extended reality technologies, such as virtual and augmented reality technologies, which at the time of writing are becoming as ubiquitous as they are potentially transformative. In this short editorial, I've been asked to discuss what role is played by the construct of affordance in my work.

First caveat: Although I make use of the construct of affordances in my research, I am not an ecological psychologist. Moreover, the way that my colleagues and I have deployed the construct of affordance is controversial among ecological psychologists and proponents of affordances in general (see, e.g. Raja et al., 2021, 2022; Anderson & Chemero, 2013; Baggs & Chemero, 2020). However, one of the aims motivating this collection is to display the wide variety, and sometimes conflicting uses, of the affordance construct—and indeed, perhaps to suggest that such disagreements can be fruitful and that affordances are open to reinterpretation in other fields, adapted to field-specific research goals.

Second caveat: I am not presenting an argument that active inference is a sound theory (although I have tried to make the case for this elsewhere) nor that the active

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inference version of the affordance construct—what I am calling Affordance 3.0, following tradition—is sounder than others. I will more modestly attempt to present the active inference conception of affordance and try to say something about where it fits into the history of the use of the affordance construct.

Caveats aside: Over the last decade, my colleagues and I have developed an approach to the free energy principle and active inference that attempts to leverage some of the conceptual resources of ecological psychology (e.g. Ramstead et al., 2018b; Friston et al., 2015; Linson et al., 2018; Bruineberg & Rietveld, 2014). In particular, we have proposed a new interpretation of the construct of affordance, based on the active inference formulation of adaptive dynamics. Active inference, at its core, is a theory of embodied cognition that is particular in that it draws both from the tools of that allow us to study complex systems in physics (e.g. from dynamical systems theory, which has been very popular in anti-cognitivist approaches to cognition) and also from information theory and geometry, which have fallen in disrepute in some circles—much to the detriment of scientific progress, in my view. The aim of the overall active inference framework is to bring adaptivity (i.e. the capacity to act proactively and constructively to perturbations) and sentience (the capacity to react adaptively to sensory stimuli) within the purview of information physics (Ramstead et al., 2018a). In a nutshell, active inference says that organisms are—either in some literal sense (Kiefer, 2017) or can be usefully modelled as (Andrews, 2021)—probabilistic models of their environment. Active inference rests on a variational principle of stationary action, known as the free energy principle, and (according to its proponents) allows us to model the action-perception cycles of agents as following a path of least action, where the action is defined as surprise. The core intuition is that agents act such as to make their sensory states unsurprising.

Active inference introduces a specific version of the affordance construct—and its use of this core construct of ecological psychology has proven controversial. Ecological psychologists have rejected the active inference formulation because it does not sit well with their core assumptions about the best manner in which to study the mind, especially perception (among other reasons). Excellent reviews/discussions include Raja et al. (2017, 2021).

I concede that these two approaches are very much in tension. However, I will argue that this core divergence between active inference and ecological psychology is not sufficient reason to think that some of the core constructs of ecological psychology cannot be redeployed under active inference to fruitfully explain some core aspects of perception, cognition, and action. Further, I will argue that this definitional pluralism is consistent with the history of the affordance construct. Indeed, theorists in the tradition of ecological psychology have themselves arguably not used the term *affordance* all that consistently (leading to debates among ecological psychologists over the meaning of the term—even its meaning in Gibson's own writings). However, arguably, far from being a problem in itself, this has led to a wealth of new work, leading to theoretical clarification and ultimately empirical progress.

This short editorial argues that the active inference concept of affordance recovers some of the core components of the affordance construct, legitimising the use of the word. So while active inference and ecological psychology may be incompatible, there is (at least arguably) nothing inherently problematic about the redeployment of this concept in the active inference framework. I first provide a woefully short review of the history of the affordance construct ecological psychology—specifically in its two historical guises, as Affordance 1.0 (which is arguably the original Gibsonian conception) and Affordance 2.0 (the newly rebooted and increasingly popular, relational version of the concept). I will then discuss affordances as they are used in the active inference framework—what I will be calling, self-servingly, Affordance 3.0. Finally, I discuss how the active inference version of affordance captures the core elements of the original definitions. We also refer the reader to Karl Friston's essay, Chap. 19 in this collection, which provides a less conceptual and historical and more technically focused description of affordances in active inference.

18.2 A Potted History of Affordance Theory

In this short section, I present with apologies a potted, necessarily partial history of the concept of affordances. For a discussion of the relevant history, please see Raja et al. (2017) and Chemero (2009).

18.2.1 Affordances 1.0

The construct of affordances was systematised by Gibson in his 1966 *The Senses Considered as Perceptual Systems*. Gibson was presenting an argument against an idea that we would today call "the poverty of the stimulus", after Chomsky's coinage. Of course, Gibson himself did not argue against this idea directly, since Chomsky only coined the term in 1980. However, Chomsky had been working on these ideas since his critical 1959 assessment of Skinner's manifesto of the behaviourist approach to language, *Verbal Behavior* (1957). By the time Gibson was developing his approach, these had made it into mainstream approaches to the study of mind.

The cognitivist assumption against which Gibson was arguing is that the streams of perceptual data to which living creatures have access are information-poor, that is, they do not contain enough information to fully represent or specify real features of the world. On this view, since our sensory receptors do not carry enough information to allow for the perception of objects, they must be enriched somehow. In particular, cognitivists believe that perception is enriched via inferences premised on information had by the agent independently of its real-time perceptual engagement

with the world. Hence, the cognitivist appeals to internal models, which harness the information necessary to make sense of sensory data.

Gibson claimed that this view is false and misleading: the standard cognitivist approach to the study of the mind was flawed because its core assumptions were flawed. In Gibson's view, the cognitivist approach results from looking at the organism passively, as a mere receiver of information. The idea that the sensory surfaces of our bodies, or sensory arrays, are information-poor is only viable if we consider them statically, in isolation from the manner in which agents sample their environments perceptually.

Gibson's theory develops an account of direct perception that he hoped would be apt to explain the perceptual abilities of agents by appealing only to information available to them directly in their sense organs. Gibson argued that when we embrace the dynamic and temporally extended nature of perception, we can see that all the information required to encode objects is readily available directly in the sensory array, specifically in the patterns of information that are directly readable from the temporally extended dynamics of sensory surfaces. When we consider the dynamics of sensory arrays, we are led to phenomena such as optical flow, occlusion, and parallax, and we discover more structure than might be assumed from a static view of perception.

Originally, the term *affordance* referred to the object of direct perception itself. In Gibson's original view, affordance is a non-relational, dispositional property of the environment. In other words, affordances are not properties of the sensory array, but rather dispositional features of the environment that are made available to the organism via access to ecological information. See Golonka and Wilson (2019) for a comprehensive presentation and defence of this position. Technically, we say that affordances are specified by the information to which the organism is privy, contained in its sensory arrays. This *ecological information* (Golonka & Wilson, 2019; Bruineberg et al., 2019) is information that is *directly readable from* the sensory arrays of the agent, especially when it is engaging actively with its environment. On this account, ecological information is constituted by higher-order patterns in sensory arrays, which organisms can leverage to specify or designate (and thereby interact with) features or properties of the environment. Thus, an affordance in the original sense is an environmental feature that is specified by ecological information, which is the kind of information that is directly registered in the sensory arrays of an organism. Ecological information specifies affordances without the need for additional information provided by inference or internal models. Thus, ecological psychologists in the wake of Gibson have defined affordances *dispositionally*: Affordance 1.0 is a property of the environment that gets specified by ecological information (Wilson, 2018).

Perception is thus *direct* in the Gibsonian account because ecological information specifies affordances, but information processing does not mediate the perception of affordances. Ecological psychologists argue that this notion of direct perception is coherent by appealing to the lawful nature of informational specification of affordances (Turvey et al., 1981): ecological information is lawfully created when a medium interacts with the features of objects in the environment, some of

these being affordances. The lawful character of these relations means, roughly speaking, that the following biconditional obtains *if property is present, then information is present* and also that *if information is present, then property is present*, such that detecting the information just is perceiving the affordance. It is thus important to keep in mind that, in the original Gibsonian conception, affordances and the information that specifies them are distinct components of the analysis of direct perception (for a discussion, see Wilson (2018)).

18.2.2 Affordances 2.0

To readers less familiar with the original use of the construct or with contemporary debates in ecological psychology, a distinct but related use of the term is probably more familiar. This usage has become popular both colloquially and in several well-developed scientific and philosophical research traditions. In response to issues surrounding the dispositional account of affordances (which exceed the scope of this paper, but are nicely reviewed in Wilson (2018)), an alternative way of thinking about affordances has emerged. In this new conception, the idea that affordances are dispositional (and, therefore, non-relational) is rejected in favour of an explicitly relational conception of affordance.

Chemero (2003, 2009) in particular expanded the use of the term affordance to describe something much broader, namely, the structured possibilities for interaction between an agent and its environment. In this new conception, an affordance becomes a relational property that obtains between properties of an organism and salient properties of its environment. More precisely, Chemero (2003, 2009) defines Affordance 2.0 as a relational property that obtains between core features of organisms, in particular the abilities that they master, and the salient features of the environment with which they are able to interact. Thus, in the Affordances 2.0 conception, a chair affords sitting to an agent that has the right body and ability, etc.

This is a remarkable mutation of the concept. Defenders of the original, dispositional concept of affordance have argued that the relational conception is problematic—the discussion is beyond the scope of this editorial, but see Wilson (2018) and Wilson et al. (2016). However, despite such dissenting voices, Affordance 2.0 has arguably become a popular, if not the most popular, way of talking about affordances. This widespread adoption of Affordance 2.0 is evident from the way that the construct has been deployed in the larger literature in psychology and neuroscience in no small part because of its relational emphases; see, e.g. Siegel (2014), Withagen et al. (2012), Gastelum (2020), and Cisek (2007). Anecdotally, in learning about embodied cognition, I learned about the relational conception of affordances before I learned about the debates over the proper interpretation of the construct and became familiar with the dispositional conception.

The point of reviewing this short history was just to show that the concept of affordance is subject to some disagreement within the very tradition that fostered it.

I turn now to a discussion of the way that the affordance construct has been put to work in the active inference literature.

18.3 Affordances 3.0? Affordances Under Active Inference

In the active inference approach, the action-perception loops of agents are modelled as if they were subject to the imperative to minimise something called *variational free energy*. In this context, variational free energy is a quantity from information theory that measures the divergence between the data that one expected to register, given a model of how that data was generated, and the actual data that was registered. A *model* in this sense is just a joint probability density that specifies the set of allowable, coordinated changes to the variables that make up the system. This can be visualised as a kind of "surface" over the state space of an organism or agent, to which trajectories of the system in its space are confined.

In active inference, organisms are cast as probabilistic models of their environments. Perception is modelled as inference: in other words, perception is formalised as inferring the most probable beliefs about what caused our sensory data, given what we know about the process causing that data. This can be cast in terms of hypothesis testing—although see Bruineberg et al. (2016). The beliefs arrived at through inference are the ones that most minimise free energy, i.e. the ones that lead to the least discrepancy with available sensory data, given some prior beliefs. In turn, action is modelled as a special kind of inference: heuristically speaking, inferences about "what I must be doing, given my model and my sensory data". The course of action or policy that ends up being selected is the one that best minimises *expected free energy*, that is, the amount of free energy expected to arise on average as a consequence of selecting actions.

With this in place, it is easy to define affordances under active inference: affordance is modelled as the (negative) expected free energy of some policy. Here *affordance* is used as a non-countable or mass noun referring to the compulsion, on the part of an agent, to pursue a particular course of action. So, unlike in the Affordances 2.0 conception, in active inference, affordance does not denote individual or individuated possibilities for interaction; nor does it denote the *object of perception* as in Affordance 1.0. Instead, in active inference, individual possibilities for interaction are formalised as policies or beliefs about possible courses of action. Intuitively, the free energy expected under each policy quantifies the degree to which an agent will find that policy compelling. So, in active inference, we have not just a means of individuating courses of actions (as policies) but also a measure of the degree to which any policy *affords being pursued*.

Finally, expected free energy itself can be decomposed into a pragmatic component and an epistemic component (Friston et al., 2015). In the active inference literature, these are called epistemic and pragmatic affordance; they correspond to different kinds of motivation to perform an action, namely, the pragmatic reward-driven component ("I open the pantry because I am hungry, and there is food in the

pantry") and the information-driven, uncertainty-reducing component ("I open the light to get to the pantry"). One nice thing about Affordance 3.0 is that such aspects of goal-directed behaviour naturally fall out of decomposition of the expected free energy; again, the reader is referred to Karl Friston's contribution in this collection.

18.4 Easy as 1, 2, 3: Comparing Affordance 3.0 and Its Cousins

I will now argue that Affordance 3.0 recovers some core features of the notion as deployed in ecological psychology. So, while there is a tension between the frameworks that leverage this construct, the concept of affordance that is deployed in active inference is arguably just one further development in the motley history of affordance theory, akin to the move from Affordance 1.0 to 2.0. I will briefly comment on the tension before recovering the core components of the affordance construct under active inference.

Active inference is not a theory of direct perception. Ecological psychology, as a field, is committed to the view that perception is not an indirect process mediated by inferences, but rather a process of *directly picking up* relevant features of the environment. And it is undeniably true that active inference theorists reject direct perception (Ramstead et al., 2018b, 2019). Indeed, on the active inference account, action-perception loops involve a kind of inference, or informational attunement, between the states of an agent and the external environment in which the system is embedded and with which it interacts. This means that active inference and ecological psychology part ways at the level of core premises.

Arguably, the active inference construct of affordance is a bona fide redeployment of the original Gibsonian construct. The contribution of active inference is to make sense of how organisms decide upon possible courses of action dynamically. Active inference models specify the inferential architecture that (its proponents believe) must be in play for the agent to be able to leverage information in a sensory array. Active inference models expand the set of phenotypic elements that are necessary to make sense of raw sensory data—these are formalised as the *prior beliefs* of a probabilistic model. Indeed, one might even view the physical structure of the sensory array as itself encoding some kind of prior about what counts as sensory data (Friston, 2011).

With respect to the mutated concept of Affordances 2.0, active inference innovates with respect to ecological psychology by distinguishing between a policy and its affordance. We believe that this distinction allows for far more precision than the relational conception. In Affordance 2.0 conception, the affordance is just a relation between embodied skills possessed by the agent and salient features of the environment. While this is useful, it is arguably not yet a dynamical theory, because it does not tell us which affordances are relevant and does not tell us how organisms evaluate the compellingness of affordances and select among them. Active inference

arguably improves upon the Affordances 2.0 construct by helping to specify the actual dynamics of engagement with the environment via the selection of policies.

18.5 Concluding Remarks

Perhaps the biggest point of connection between Gibson's ecological approach and active inference is their common aim to make the science of sentient systems continuous with the rest of physics. Gibson intended to extend the analysis of lawlike regularities from physics into psychology, with the hope of developing a bona fide physics of sentience, in line with the developments of mechanistic science since the seventeenth century, especially early Galilean and Newtonian physics (Raja et al., 2017). As remarked at the outset, this is also the aim of those who leverage the (variational) principles of physics that underwrite active inference, to establish a bona fide physics of sentient systems (Ramstead et al., 2018b; Friston, 2019).

The active inference approach to affordance also comes with some interesting implications for research. One such implication, which was pointed out to us by the editor of this collection, is that active inference agents can be used to generate hypotheses about the relation between perception, salience, motivation, and behaviour, which is critical to neuroscience in general. Paraphrasing Dobzhansky, "nothing in neuroscience makes sense except in the light of behaviour". To be able to simulate motivated belief-driven behavioural responses will surely be a boon to neuroscience; and active inference formalisations of the concept of affordance can help to make these goals achievable.

The reformulation of affordance within active inference, a framework that rejects direct perception, is consistent with some of the core developments of the recent history of philosophy, in which notions of "the given" and direct perception have largely and roundly been rejected. In analytic philosophy, at least since the advent of Sellar's 1956 *The Myth of the Given*, the idea that there is something like a non-propositional perceptual given that grounds empirical claims has largely been rejected. In continental philosophy, this is evident in the general move from phenomenology, which is concerned with *pure* descriptions of lived experience, to hermeneutics, which focuses on interpretation, not unmediated perception (Gadamer, 2003). Arguably, direct perception is no longer seen as a tenable option, and it may be that the "reboot" of the concept in active inference is a sign of the times.

Finally, and perhaps controversially, it may be that a better term for Affordance 3.0 is *drive*. Indeed, at a conceptual level, what proponents of active inference call affordance corresponds well to the Freudian construct of drive (Carhart-Harris & Friston, 2010; Solms, 2021; Solms & Zellner, 2012). Drive is an energetic pressure to act in specific ways, which seems to correspond well with the active inference version of affordance.

This paper was a modest attempt to present the active inference concept of affordance in light of the recent history of the construct. We hope that the discussion will motivate greater interaction between affordance theory and active inference.

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Chapter 19
Reflections on 20 Years of Affordance-Based Design

Jonathan R. A. Maier

19.1 Reflections on 20 Years of Affordance-Based Design

M. J. McDonald, in an unsolicited review (McDonald, 2013) of my book, *Affordance Based Design: Theoretical Foundations and Practical Applications* (Maier, 2011), opined that the application of affordances to engineering design was the "most significant advance to design theory" that he or she had seen in 30 years of interest in the field. However, they also lamented the lack of a concise definition of the term *affordance*. Hopefully, the essays in this book, and this essay in particular, will help bolster their confidence in the former and help clarify the latter!

As a young researcher, I had come across a copy of Don Norman's remarkable book *The Design of Everyday Things* (Norman, 1988) by chance in the late 1990s, in the Georgia Tech bookstore. Up until then, my early research had been into product family design. As I read Norman's book, the relevance of the idea of affordance to engineering design became immediately apparent.

In the back of my mind, I had been unsatisfied with the various conceptual bases on which engineering design research had been supposed. Function-based design was very prevalent, but it seemed to me that so many things that designers needed to consider were not functional in nature. My mentor at Georgia Tech, Farrokh Mistree, famously proposed an alternate basis, called Decision-Based Design (Mistree et al., 1990), inspired by earlier work by Herbert Simon and others on decision theory. The basic idea was that the design process boiled down to a series of decisions to be made along the way, which led to a flurry of research on decision support tools.

Then there was Nam Suh's Axiomatic Design (Suh, 1990), a more theoretical approach which attempted to establish design on a small set of axioms similar to

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those of Euclidean geometry. I found this interesting, but the more I looked at it, the more the axioms seemed less and less like axioms and more and more like assumptions or just hypotheses. I examined various other proposals from engineering researchers as well. (Incidentally, despite the technical field being known as *Design Theory and Methodology*, the vast majority of work in the field emphasizes methodology. Comparatively fewer efforts have addressed underlying theory on which methods should be developed; see Braha et al. (2013).)

Perhaps there is something about the engineering mind—that has been trained to look at solving problems in a very systematic and typically mathematical way—that has trouble taking enough distance from *design problems* such that they can see the difference from regular analytical *engineering problems*. (*Thinking like an engineer* is a common phrase and even the title of our first-year engineering textbook at Clemson University where I now teach.)

Don Norman, as a psychologist, had no such limitation and made the great leap of appropriating Gibson's original concept of affordance from psychology (Gibson, 1979) to product design (Norman, 1988). Under the supervision of my graduate school advisor, Georges Fadel, I took the concept of affordance from product design to engineering design more broadly, that is, from *the design of everyday things* to *the design of everything* (Maier & Fadel, 2001).

Gibson himself had intimated as such, having written variously about products of human design ranging from the architecture of buildings down to the design of chairs (Gibson, 1976, 1979).

My research quickly led to a distinction between what I called Artifact-User Affordances, which describe most of how Norman used affordances, and Artifact-Artifact Affordances, which describe, among other things, how gears mesh, how chairs stack, how pens and pencils clip onto shirt pockets, etc. Though controversial, I believe that innovation is the key to allowing affordances to be used as a basis for design. Thereby, affordances can describe a myriad of issues related to human use and more technical aspects. Interestingly, those technical aspects sometimes admit a useful functional description, such as printing ink on paper, but some aspects do not, such as all stationary (or *static*) structures, like bridges, chairs, columns, etc. whose main *function* is just to support weight. Knowing that a bridge or a chair or a column has to support weight tells the designer very little about how that bridge or chair or column must be designed. Most of what makes a bridge a bridge, or a chair a chair, are non-functional in nature but can be described quite easily (in my opinion) and comprehensively using affordances. (An expanded discussion of these theoretical issues, and lots of other technical examples such as air conditioners, automotive tooling, fishing rods, etc., are in my book (Maier, 2011).)

But the most surprising application of affordances to design has to be to natural phenomena.

Gibson himself again intimated at this, having discussed the affordances between people and the natural environment and indeed between people and other people (Gibson, 1979).

Why does a person walk the way he or she does, and a dog walk the way a dog does, and a rabbit hop the way a rabbit does? *Because that is what each animal's*

legs afford to the rest of their body. If the animal suffers a leg injury, they walk or hop differently.

It could even be argued that the physiological development of any organism is a result of what a combination of its genes and its environment affords. Even more broadly, the inanimate natural world can be described the same way. The behavior of the universe is a result of what the structure (as revealed, at least in part, in the laws of physics) of the universe affords. In all cases, from cosmology and biology back to engineering design and architectural design—even computer science—structure influences behavior through what those structures afford (Maier, 2006).

This brings us back to McDonald's chief criticism. Perhaps all this is worthless if we can't precisely say what an affordance even is. (Or perhaps not, as biologists apparently have no difficulty researching biology, despite the fact that *life itself* is famously difficult to define.) I do agree that if an affordance can mean anything, then it is so ambiguous that it means nothing.

Before I propose a more succinct definition than I have before, first let me assert that such a definition cannot be done in the form of a mathematical equation (with apologies to other essays in this book that might attempt to do so). I think a central mistake that many engineering researchers make is to apply the mathematics of analysis to the field of design which requires both analysis and synthesis and creativity. While useful to an extent, beyond that extent, using analytical math to describe design is as futile as using analytical math to describe love. Unfortunately, we do not have much mathematics yet that is not analytical. When I realized this and went looking for mathematics to describe the relationships between designers, users, and artifacts, I found the 150-year-old pioneering work of Charles Peirce on the logic of relatives (Peirce, 1873). Unfortunately, that initial work is very limited, and to my knowledge, little has been done to advance this kind of relational mathematics since that early work of Peirce.

An interesting result from applying Peirce's logic to affordances is the ability to consider the computability of affordances (just as we can consider the computability of other relations) by attempting to write an algorithm to determine the quality of that affordance (see Maier, 2015).

But the key point here is that the mathematics available do not get us any closer to defining what exactly an affordance is.

Like any other relation, the definition of that relation is external to the set of elements (in the case of affordances, those elements would typically be users and/or artifacts) on which that relation exists. Addition, for example, is a concept that cannot be defined using just integers. We need to be able to define any relation using either natural language or some formal language. Such formalisms themselves often rest on unproven axioms, so to posit a formal language to describe affordances seems like an unnecessary exercise. To wit, natural language will have to suffice.

(As a related aside, I would note that the lack of a precise or formal definition of affordance has clearly hindered the further development of affordance-based design. Many papers I have reviewed contain glaring misunderstandings of what affordances are, often describing physical components or component properties as affordances—like fingernails on a chalkboard to me, but perhaps I am partially to blame.)

So here it is then, a revised definition of affordance, after 20 years of reflection on the subject:

An affordance is a relationship between two (or more) interacting systems that describes a potential behavior that neither system can exhibit alone.

Thus, to be clear, an affordance cannot be a physical component of a design or a property of a single component. An affordance is not the behavior itself when it happens. What the systems are need not be restricted in general, but in design, most often we are concerned with the affordances involving users and artifacts. Each system can be a group (of people or parts) or an individual (person or part).

Table 19.1 includes several affordances in tabular form. In all cases, the affordance describes the potential behavior between system 1 and system 2.

As a general rule, if an affordance cannot be described as x-ability, it is probably not an affordance and may in fact just be a property of a single system like a component part or a behavior. Likewise, if two potentially interacting systems cannot be identified, whatever is being described is probably not an affordance. Sometimes a special word already exists in the language for an affordance, such as *comfort*, a word which already implies the physical and mental state of a person in relation to their immediate surroundings.

Some examples of things that are not affordances include:

- A part of an assembly.
- A user of a product or part of a user such as a hand.
- A physical property of an object, such as its color or density.

Thus, affordances are *not* so general that they can describe anything. They only describe certain things, the things that can happen between interacting systems. Happily, it is not the case then that we must discard the idea of affordances as being ambiguous and overly general. Many other useful concepts are very broad in nature, and thus difficult to define and difficult to master in practice, yet have proven useful and even indispensable. In earlier work, I addressed this issue specifically (Maier & Fadel, 2007), using the analogy of color. There are an infinite number of possible colors. Color is a concept that is impossible to understand by (or to explain to) a person blind from birth. Yet, color is indispensable to artists, most of whom master the art of applying its subtleties.

Another way to describe or document affordances is in the form: *system 1* affords *behavior* to *system 2*. This method avoids the necessity of naming each affordance

Table 19.1 Example of affordances, systems, and behaviors

Affordance	System 1	System 2	Behavior
Typability	Person	Keyboard	Typing
Turnability	Gear 1	Gear 2	Power transmission
Legibility	Person	Letters	Reading
Comfort(ability)	Person	Air conditioner	Cooling air
Sitability	Person	Recliner	Reclining
Clampability	Clamp	Loose objects	Clamping

and thus some of the awkwardness of a list of affordances all ending in *ability*. Using the affordances in Table 19.1:

- Keyboards afford typing to people.
- Two gears afford power transmission.
- Letters afford reading to people.
- Air conditioning affords cool air to people.
- Recliners afford reclining to people.
- Clamps afford clamping to loose objects.

A third way to describe or document affordances, and the least general, is the teleological form: an affordance is *what system 1 is for (with respect to system 2)*. This kind of description implies intent on behalf of either a designer of that affordance or on behalf of one of the two interacting systems. Again using the affordances in Table 19.1:

- Typing is what a keyboard is for (to a person needing to type).
- Power transmission is what two gears are for (to a mechanical designer needing to transmit power).
- Reading is what letters are for (to a person needing to read).
- Cool air is what air conditioning is for (to a person needing to be cooled).
- Reclining is what recliners are for (to people wanting to recline).
- Clamping is what a clamp is for (to a person needing to clamp loose objects).

Generally, I think it is a good practice to adopt a single method for describing affordances in any given project, whichever seems most appropriate to the project at hand.

All of the properties of affordances I have previously enumerated (see Maier, 2011) still apply, namely, complementarity (that two or more interacting systems are necessary for an affordance to exist), imperfection (that, in general, affordances cannot be optimized in the way that some mathematical functions can be), polarity (that affordances can be considered positive or negative, from the standpoint of a human user), multiplicity (that multiple affordances can exist between the same two or more systems), and quality (that affordances vary in quality, instead of existing or not existing in a binary sense).

Using my revised definition of affordances, I had to return to some of the affordances I have discussed in previous work, and I must admit that some of them do not meet the standard of the new revised definition. In particular, I had to reflect on whether or not affordances could be self-referential. Can a system afford a behavior to itself (i.e., can system 1 = system 2)? To some extent, that is an open question, but my current thinking is that the answer to this question is no.

The instance in which this distinction would be most interesting is my earlier proposition that *organisms afford life* (see Maier, 2011). But life is a behavior of organisms. Using the teleological definition, though, perhaps life is what an organism is for. This is certainly an avenue for future thought.

I had also previously written that *brains afford thinking* (see Maier, 2011). Our brains could be said to afford thinking (one of its behaviors) to the rest of the body,

just as a liver could be said to afford filtering (one of its behaviors) to the rest of the body, or legs afford walking to the rest of the body. However, the brain is part of the body, just as the liver and legs are. When a body walks using its legs, the legs are also walking. So there is indeed the necessity for self-reference whenever system 1 is a part of system 2. Again, this issue deserves more exploration.

This kind of entanglement certainly makes behavior difficult to predict. As mentioned above, the behavior of the universe can be said to result from what its structure affords. To take a simple example, between two interacting particles, there are many affordances, describing potential behaviors. They may magnetically attract or repulse depending on their orientation. They may transfer heat from the warmer to the cooler. They may collide and perhaps bounce, deform, or shatter. They will certainly gravitationally attract. The amount of attraction is dependent upon both the mass of the first particle and the mass of the second particle—interestingly, it is the product of the two masses, not their sum, that determines the resulting force, in Newton's familiar equation for universal gravitation. But when a third particle is introduced, the resulting behavior is famously unsolvable analytically. Yet the universe has no trouble in determining the behavior in real time. Perhaps this simple example speaks to the larger difficulty we face in attempting to predict the behavior of real users with the products we design, as again we are confronted with the limitations of analytical mathematics.

Finally, the editor asked "perhaps a last, and more provocative question; are affordances measurable, if not, then how are they identified?"

My answer to the first part of the question is an unequivocable yes: affordances are measurable, in the sense that their quality can be measured. For example, the quality of the affordance of typability of a keyboard design can be measured in a variety of ways, such as the speed at which users can type on it, in words per minute, or more subjectively in terms of finger or wrist discomfort after typing for a certain amount of time.

The answer to the second part of the question is a little less straightforward, because we need to distinguish between (1) the necessity of designers identifying the affordances of an artifact with respect to certain users and (2) the ability of users to identify the affordances of an artifact. Both are critical. For the latter, ecological psychologists since Gibson himself have discussed the ways in which people can identify, or, in their terminology, directly perceive, the affordances of artifacts. For the former, more work needs to be done. Designers who are better at anticipating the affordances of a new product design would clearly have an economic advantage over less capable designers.

So in this brief article, I hope I have helped answer the call for a more precise definition of affordances. As with all answers to questions in science, however, that answer merely raises more nuanced and interesting questions. Hopefully, researchers, such as those surveyed throughout this new volume, will continue to elucidate and apply the powerful concept of affordance for decades to come.

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Chapter 20
Affordance and Active Inference

Karl Friston

My reading of affordance is that it underwrites the enactive aspect of perception. Indeed, if one wanted to talk about sentient behaviour, it would be almost impossible not to commit to some notion of affordance. Affordance plays a special role in active inference and has a privileged position within the larger scheme of self-organised behaviour. Let me explain.

Active inference (Parr & Friston, 2017) is a corollary or process theory that follows from the free energy principle (Friston, 2010). Put simply, the free energy principle is a somewhat deflationary account of systems that actively self-organise to ensure they keep themselves in some characteristic or recognisable state of being. Technically, this means that they have an attracting set of states that characterises the system in question (Crauel & Flandoli, 1994). The very existence of this attracting set means that self-organising systems, whether particles or people, must have certain properties.

One way of articulating these existential properties is in terms of self-evidencing (Hohwy, 2016; Palacios et al., 2017). In other words, everything a particle or person does or thinks has to be in the service of soliciting evidence for its own existence. Formally, this means that internal (brain) states and active states (like actuators or autonomic reflexes) respond to sensory input in a way that must increase the evidence for a model of how that input was generated. In statistics, this is known as the marginal likelihood, which means that all my perception and behaviour is aimed at making the sensorium as likely—or predictable—as possible, given the kind of creature that I am. So where does affordance get into the game?

There are many ways of complying with the free energy principle. In terms of active inference, this means that there are many ways of understanding sentient behaviour as realised in different self-organising systems. For simple systems—like

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particles and plants—the way that they act on the world is largely in the moment, via a repertoire of reflexes. One might ask how does a reflex increase marginal likelihood? The answer is straightforward: under certain simplifying assumptions, increasing model evidence is the same as decreasing surprise or prediction errors. This means that if I predict that my body will do this—and my motor or autonomic reflexes fulfil those predictions (Feldman, 2009; Gu & FitzGerald, 2014)—then I can actively suppress prediction errors quickly and efficiently.

Those that cannot be suppressed by action can be resolved by changing my predictions: literally, changing my mind about states of affairs generating sensory input. These two ways of minimising prediction error can be regarded as action and perception that, together, constitute sentient behaviour in a properly enactivist, embedded and embodied sense (Bruineberg & Rietveld, 2014; Pezzulo et al., 2015; Seth, 2013). However, there are other ways of self-evidencing that may be more apt to describe creatures like you and me. Figure 20.1 provides an illustrative example of the biologically plausible action (and action-observation) that can be reproduced under this simple kind of active inference.

For particles and plants (and thermostats and viruses), it may be entirely sufficient to act in the moment and resolve any prediction errors that cannot be actively suppressed by changing internal states, e.g. intracellular states or states of mind (Calvo & Friston, 2017; Friston et al., 2015a). However, if the generative model—generating predictions necessary to form prediction errors—includes a model of the future, then the game changes fundamentally. This is because certain creatures may be able to model the consequence of their actions. If they can do this, they can then select those plans or policies that will secure the greatest evidence for their existence in the future.

In other words, actions can be selected from plans that minimise prediction error or surprise expected after acting. This means that there is a first principle account of how we choose to act—and which courses of action we commit to. This account requires that we select those actions that minimise expected surprise, namely, that minimise uncertainty following the action. Put simply, I will choose those actions that either resolve uncertainty or avoid surprises. So, what does this mean in practice?

If I am a creature that can predict the consequences of my actions, then there are two ways in which I can minimise expected surprise. First, I could choose those actions that resolve my uncertainty about states of affairs in the world. For example, I could look behind me to see if I am being followed or not. Or I could watch the news on television to see how international affairs are unfolding. In short, I could indulge in some kind of epistemic foraging. This aspect of behaviour is closely related to the notion of intrinsic motivation in robotics and artificial curiosity in machine learning (Barto et al., 2013; Oudeyer & Kaplan, 2007; Schmidhuber, 2010; Schwartenbeck et al., 2019). However, there is another way I can minimise surprise that rests upon the kind of states or outcomes that characterise me. For example, I tend to take those actions that keep my introspective sensations within homeostatic bounds—and I tend to avoid noxious outcomes (Allen et al., 2019; Seth, 2013, 2014).

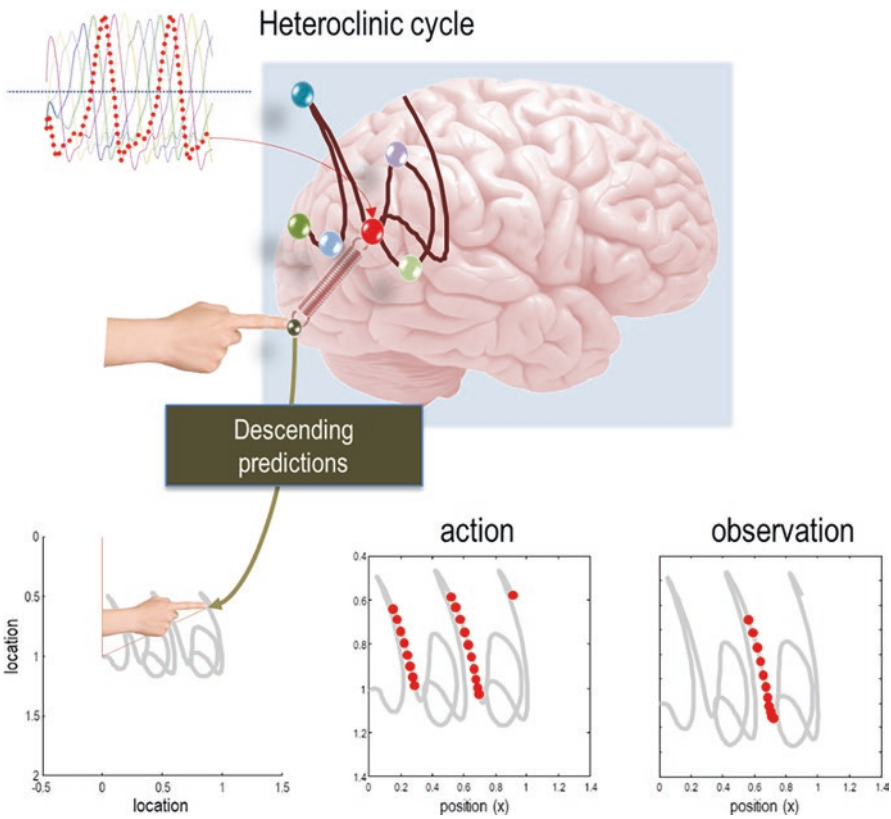

Fig. 20.1 *Autonomous movement*. This figure shows the results of simulating active inference (here, writing), in terms of conditional expectations about hidden states of the world, consequent predictions about sensory input and ensuing behaviour. The autonomous dynamics that underwrite this behaviour rest upon prior expectations about states prescribed by a generative model with autonomous dynamics that can be thought of as a central pattern generator—modelled with Lotka-Volterra dynamics: these are the six coloured lines in the upper left panel. In this generative model, each state is associated with a location in Euclidean space that attracts an agent's finger. In effect, the agent's internal (e.g. neuronal) states then supply predictions of what sensory states should register if the agent's beliefs were true. Active states try to suppress the ensuing prediction error (i.e. maximising accuracy) by reflexively fulfilling expected changes in angular velocity, through exerting forces on the agent's joints. The subsequent movement of the arm is traced out in the lower left panel. This trajectory has been plotted in a moving frame of reference so that it looks like synthetic handwriting (e.g. a succession of 'j' and 'a' letters). The lower left panels show the activity of the fourth hidden state under *action* and *action-observation*. During action, sensory states register both the visual and proprioceptive consequences of movement, while under action-observation, only visual sensations are available—as if the agent was watching another agent. The red dots correspond to the time bins during which this state exceeded an amplitude threshold of two arbitrary units. They key thing to note here is that this unit responds preferentially when, and only when, the motor trajectory produces a downstroke, but not an upstroke. Please see Friston et al. (2011) for further details. Furthermore, with a slight delay, this internal state responds during action and action-observation. From a biological perspective, this is interesting because it speaks to mirror neuron activity (Gallese & Goldman, 1998; Kilner et al., 2007; Rizzolatti & Craighero, 2004)

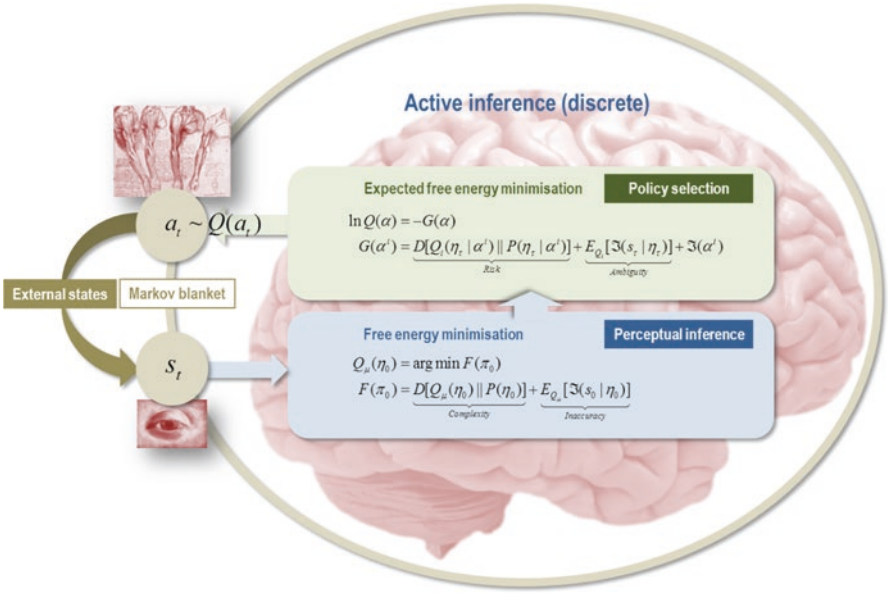

Fig. 20.2 *Bayesian mechanics and active inference*. This graphic summarises the belief updating implicit in the minimisation of variational and expected free energy. It provides a generic (active) inference scheme that has been used in a wide variety of applications and simulations, ranging from games in behavioural economics (FitzGerald et al., 2015) and reinforcement learning (Schwartenbeck et al., 2015) through to language (Friston et al., 2017c) and scene construction (Mirza et al., 2016). In this setup, discrete actions solicit a sensory outcome that informs approximate posterior beliefs about hidden or external states of the world—via minimisation of variational free energy under a set of plausible policies (i.e. *perceptual inference*). The approximate posterior beliefs are then used to evaluate expected free energy and subsequent beliefs about action (i.e. *policy selection*). Note a subtle but important move in this construction: the expected free energy furnishes prior *beliefs about policies*. This is interesting from several perspectives. For example, it means that agents infer policies and, implicitly, active states. In other words, beliefs about policies—encoded by internal states—are distinct from the active states of the agent's Markov blanket. With a sufficiently deep generative model, agents can infer hidden states under plausible policies. This means the agent predicts how she will behave and then verify those predictions based on sensory samples. In other words, agents garner evidence for their own behaviour and actively self-evidence. In sum, this means the agent (will appear to) have elemental beliefs about its enactive self—beliefs that endow it with a sense of purpose, in virtue of the prior preferences that constitute risk. A key insight from formulation is that the generative model can be quite different from the process by which external states generate sensory states. In effect, this enables agents to author their own sensorium in a fashion that has close connections with econiche construction (Bruineberg & Rietveld, 2014). Please see Friston et al. (2017b) for technical details and Friston et al. (2017a) for a discussion of how the implicit belief updating might be implemented in the brain

Figure 20.2 provides a schematic based upon something called a Markov blanket that distinguishes between states that are internal to an agent and states that are external. In this setup, external states influence internal states via sensory states, while internal states influence external states via active states. This reciprocal or circular causality can be regarded as a mathematical image of the action-perception

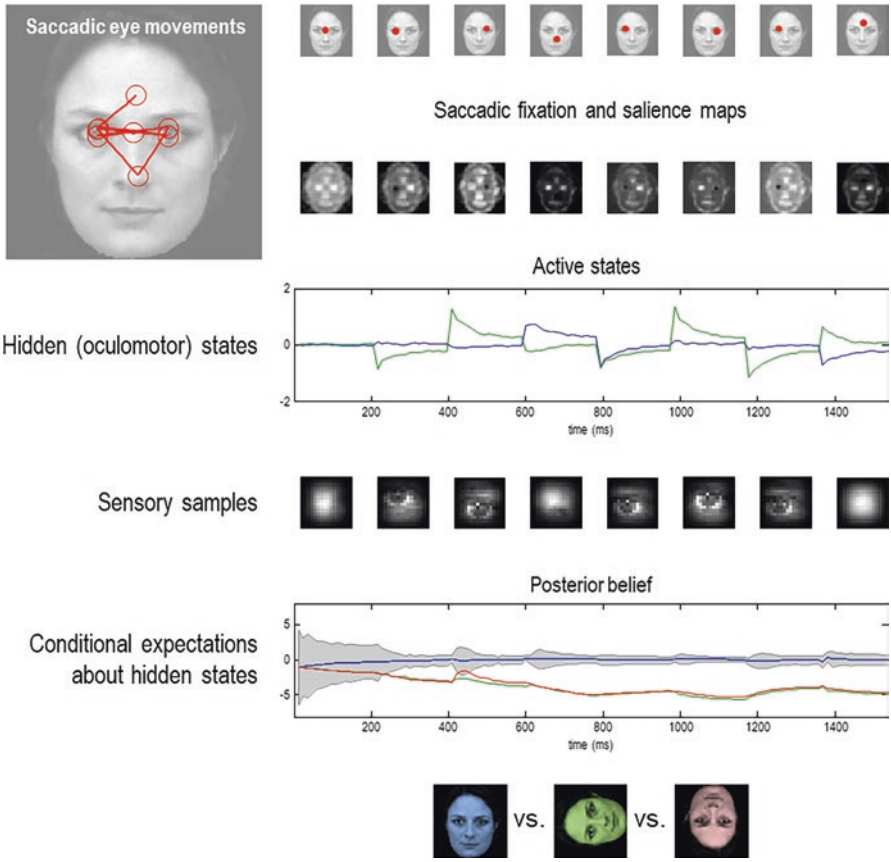

Fig. 20.3 *Epistemic foraging*. This figure shows the results of a simulation in which a face was presented to an agent, whose responses were simulated by selecting active states that minimised expected free energy following an eye movement. The agent had three internal images or hypotheses about the stimuli she might sample (an upright face, an inverted face and a rotated face). The agent was presented with an upright face, and her posterior expectations were evaluated over 16 (12 ms) time bins, until the next saccade was emitted. This was repeated for eight saccades. The ensuing eye movements are shown as red dots at the end of each saccade in the upper row. The corresponding sequence of eye movements is shown in the inset on the upper left, where the red circles correspond roughly to the proportion of the visual image sampled. These saccades are driven by prior beliefs about the direction of gaze based upon the salience maps in the second row. These salience maps are the expected free energy as a function of policies, namely, where to look next. Note that these maps change with successive saccades as posterior beliefs about the hidden states, including the stimulus, become progressively more confident. Note also that salience is depleted in locations that were foveated in the previous saccade, because these locations no longer have epistemic affordance (i.e. the ability to reduce uncertainty or expected free energy). Empirically, this is known as inhibition of return. Oculomotor responses are shown in the third row in terms of the two hidden oculomotor states corresponding to vertical and horizontal eye movements. The associated portions of the image sampled (at the end of each saccade) are shown in the fourth row. The final two rows show the accompanying posterior beliefs in terms of their sufficient statistics and stimulus categories, respectively. The posterior beliefs are plotted here in terms of

cycle. However, in this instance, actions are chosen carefully from (posterior) beliefs about the consequences of action, namely, chosen carefully according to their affordances.

On this view, the imperatives that underwrite planning just are affordances. The two kinds of affordances we have considered are *epistemic affordances*—that resolve uncertainty through epistemic foraging—and *pragmatic affordances* that ensure outcomes that I find unsurprising and comfortingly familiar. When combined, these dual aspect affordances can be expressed as a single expected surprise, called expected free energy (Friston et al., 2015b; Parr and Friston, 2019). See also Fig. 20.2.

Technically, this means that the existential imperatives for planned behaviour can be cast in terms of responding to epistemic and pragmatic affordances. The epistemic affordance reflects my current beliefs—and the accompanying uncertainty about the world 'out there'—while pragmatic affordance reflects the propensity of my actions to evince the states and outcomes that characterise creatures like me. Typically, when placed in a new environment, epistemic affordances predominate until uncertainty has been resolved, leaving the pragmatic affordances to supervene (Friston et al., 2015b; Moulin & Souchay, 2015). Behaviourally speaking, this means that self-evidencing—under generative models of the consequences of action—initially invokes exploratory behaviour that gives way to exploitative behaviour, when I am familiar with my new environment. In this sense, affordance is at the heart of sentient behaviour, where behaviour is read as the things we choose to do. An example of epistemic affordance and information foraging is provided in Fig. 20.3 that simulates active visual searches to resolve uncertainty about the visual scene generating sensory inputs.

Because this framing of sentient behaviour is based upon a first principle account, it has a formal (mathematical) basis. This means it is easy to quantify affordances in exactly the same way that a statistician can quantify the evidence for one model of her data versus an alternative to model or hypothesis. Indeed, the objective function behind active inference is used in many statistical and machine learning schemes, where it is known as variational free energy or an evidence bound (Winn & Bishop, 2005). This is important because it means that the expected free energy is equally well-defined and quantifiable. In turn, this means that epistemic and pragmatic affordances can be measured quantitatively (Friston et al., 2015b). Crucially, because they are both expressed in terms of log probabilities, they have natural units. These can be read as bits of information (or nats when using natural logarithms).

Fig 20.3 (continued) posterior expectations and 90% confidence intervals. The key thing to note is that the expectation about the true stimulus supervenes over alternative expectations, and, as a result, conditional confidence about the stimulus category increases (and the confidence intervals shrink to the expectation). This illustrates the nature of evidence accumulation when selecting a hypothesis or percept that best explains sensory states. Within-saccade accumulation is evident even during the initial fixation with further stepwise decreases in uncertainty as salient information is sampled at successive saccades. Please see Friston et al. (2012a) for further details

The implication of this formulation is as follows: if one knew—or estimated—the generative model that you were using to explore your environment, then one could evaluate the epistemic and pragmatic affordance of each plausible plan of action in terms of bits (or nats). In so doing, one can effectively cast the value of information in the same currency as pragmatic value, sometimes described as utility in economics (Fleming & Sheu, 2002; Howard, 1966; Kauder, 1953). This means that my preferred outcomes or states of being can be quantified in relation to my imperatives to resolve uncertainty about the environment that I am exploring. Notice that something quite subtle has happened in this treatment of affordances, which we will conclude with.

Typically—and certainly in the twentieth century—affordances were assumed to be attributes of an external, or at least lived, world (Cisek, 2007; Gibson, 1977). In other words, that chair affords the opportunity for sitting; that door affords the opportunity for opening; that window affords the opportunity for looking; and so on. However, in the active inference, affordance becomes an attribute of the plan or course of action (Bruineberg & Rietveld, 2014; Cisek, 2007; Friston et al., 2012b; Veissiere et al., 2019). In other words, it is the affordance of *sitting*, *opening* or *looking* that underwrites policy selection. This is a subtle move that means one cannot separate affordance—as an attribute of the thing to be acted upon—from the acting per se. This brings us back to the fundament of active inference, namely, the way we perceive our world is inherently enactive: there is nothing more than sentient behaviour. Perhaps this is most simply expressed as we do not *see*, we *look*. We do not *hear*, we *listen*. We do not *feel*, we *touch*. On this view, it is the looking, listening and feeling that realises affordances.

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