Epistemic Affordances and Active Inference in Socio-Cognitive Design

Klaus Schwarzfischer

Abstract

Methodological problems arise when a special case is confused with the general principle. You will find *affordances* only for 'artifacts' if analysis is restricted to 'artifacts.' The general principle, however, is an 'invitation character,' which triggers an action. Consequently, an action-theoretical approach is recommended. Accordingly, humans are not passive-receptive beings but actively produce *action effects* that open up the world to us (through 'active inferences'). This 'ideomotor approach' focuses on the so-called 'epistemic actions,' which guide our perception as conscious and unconscious cognitions. Accordingly, the seemingly passive perception is dissolved into a multitude of epistemic actions (e.g. eye movements, tactile operations, etc.). The action theoretical approach of ›enactive cognition' takes into account that every form is consistently processualized. Thus, each 'Gestalt' is understood as the process result of interlocking cognitions of 'forward modelling' (which produces *anticipations* and enables *prognoses*) and 'inverse modelling' (which makes hypotheses about *genesis* and *causality*). These cognitions are fed by previous experiences of real interactions, which later change into mental trial treatments, which are highly automated and often unconsciously. Every object can have such affordances that call for instrumental or epistemic action. In the simplest case, it is the body and the facial expressions of our counterpart that can be understood as a question and provoke an answer/reaction. In the same way, our own body and facial expressions act as affordances to our counterpart. Thus, emotion is not only to be understood as expression (output) according to the scheme 'input-processing-output,' but acts itself as a *provocative* act (input). The reaction to this clarifies what kind of situation we are in. Any unclear situation thus shows *affordances to epistemic actions*. Consequently, artifacts are neither *necessary nor sufficient conditions* for affordances. Rather, they exist in all areas of cognition—from enactive cognition to embodied cognition and social cognition.

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The Efficiency of a Systematic Approach

This paper argues from a design theorist view why artifacts are neither specific for *design* nor for *affordances*. Some readers might be perplexed by that, but their irritation will vanish—as this text progresses from prejudgments to solid knowledge. A short preliminary round should help to show to which extent this optimism is reasonable.

We often gain a methodical surplus, if we look for the simplest case of a phenomenon. Ideally, we generate a precise definition of an object, of which we have just had unrelated examples before. Mostly, the object needs to be resolved in its generative processes by an operationalizing—as Siegfried J. Schmidt proposes with regard to scientific theory (Schmidt, 2010). The *microgenesis* of those objects (in German *Aktualgenese*) consists of specific processes which are resulting in that object. In the context of design and aesthetics this may feel unusual, because of the fact that mostly artifacts are thematized there. In his dialogue 'Hippias Major,' however, Plato already made the point that it does not suffice to list beautiful things in order to understand the essence of beauty. In fact, we have to explicate the definite process which is the base of each and every aesthetic experience (Schwarzfischer, 2019). A similar problem can be found in design theory, also, where designed artifacts were focussed for a long time without a strict definition of the term 'design.' I showed that operationalizing is fruitful in this case also (Schwarzfischer, 2010 a and 2010 b[1]). The focus will change from artifacts (as possible results of processes) to interventions themselves (as processes which are definable by necessary and sufficient conditions).

What exactly will be the methodic benefit of that operationalizing? First of all, this is the crucial step from *description* to *explanation* of a phenomenon—and therefore, from story telling to science. The explanation may result in a process flow diagram, but formalization is optional. Even when no such model like a block diagram is generated, the understanding of the phenomenon now is fundamentally different. This progress means the step from a special case to the general principle. Before that, we just had single examples of something which we met in random situations. Now, we are able to adress the *possibility* space *of the phenomenon. Especially on 'design' an enormous difference shows up: We will no longer analyze exclusively artifacts (which are just a special case). The process of formation itself will be focussed (as the general principle). Then, any volitional action is a design problem because to define* 'design' as an

intervention seems to be the only option (according to Schwarzfischer, 2010 a and 2010 b). That action-theoretical approach is astonishingly productive as this paper develops. Similarly, this holds good for 'aesthetics,' although there is a traditional fixation towards 'artworks' which prevented those theories from unfolding actual explanatory force and/or noteworthy use of application. Essential for this would be the capability for prognosis and the concomitant *falsifiability* (which necessarily exeeds a description of the given). Both require a theoretical access to cases that did not occur yet, in terms of adressing the possibility space (from which prognoses can be derived). For aesthetics this was accomplished systematically by modelling the aesthetic experience itself as a microcognitive process instead of 'measuring' static artifacts (Schwarzfischer, 2019). As a result, it becomes apparent that the basic process of any aesthetic experience can be identified as an evolutionary learning reinforcement. Thus, any acting can produce an aesthetic experience (e.g. playing, dancing or thinking as well as alone as with others). Amazingly, in this field it was again an action-theoretical approach which based the operationalization—although the verdict of 'disinterested appreciation' dominated (and paralyzed) aestheticians for generations[2]. To escape that, we chose a finer-grained analysis. Thus, each perception dissolves in several *perceptual acts* as a feature of any active observer (like men and animals on the contrary to trees). Concrete perceptual acts are eye movements or tactile scanning, for example. We can interpret those perceptual acts as 'epistemic actions' (which do not aim to change the world but just derive information in order to optimize the cognitive model of the world)[3].

This paper aims to outline the general principle of affordances instead of attributing a 'stimulative nature' (German *Aufforderungscharakter*) to artifacts only—as widely spread in literature. A more systematical and historical view refers to active observers, which is why an action-theoretical approach may be productive again. As a result, the possibility space of affordances is much wider than one might think when reading the conservative analyzes of artifacts[4]. On closer consideration, the spectrum of affordances ranges from intra-psychic *microcognitions* to processes of *social cognition.* This is less surprising when reflecting that affordances is orignially a concept of cognitive sciences[5].

Roots of the Affordance Concept in Cognitive Biology

The term ›affordances‹ was coined by the perceptual psychologist James J. Gibson as widely known[6]. The idea of affordances, though, is a bit older than Gibson's references to the Gestalt psychologists Kurt Koffka and Kurt Lewin suggest. Especially the concept *Aufforderungscharakter* (as an 'invitation character' or a 'call to action') by Lewin is generally identical with 'affordances' and may therefore be rated as a parent[7]. Andrea Borsato (in press) goes into the differences:[8]

> […] both authors [Lewin und Gibson] emphasize that such a connection does not exist per se, but just for a specific subject in a specific situtation, because the postbox does not point per se to post a letter by its ›invitation character‹ or by its 'affordance' but just for a subject who wrote a letter and wants to get it delivered. Already J. J. Gibson clarifies that this parallelism isn't more far-reaching. After done action the object loses its ›invitation character‹ but not its 'affordance:' For Lewin, the postbox does not call any longer for action when the letter is posted, whereas for Gibson the postbox keeps its 'affordance' also when the posting is done.

This quotation explains why in design the affordance is closely coupled with artifacts. In design theory affordance is seen as an object feature (acc. to Gibson) and not as a subject disposition (acc. to Lewin). The postbox example highlights the difference because the 'invitation character' as a disposition has a dynamical history itself— the 'invitation character' arises by writing a letter and leaves by posting the letter. Whereas Gibson claims that an affordance exists in a stable manner over time. Hence, it is a feature of the postbox. This assumption is problematic as postboxes (like every object) initially obtain their functional role by the users socialization. And, indeed, Gibson indicates, that affordances presuppose specific processes of learning.[9] Isn't this inconsistent, when affordances require learning processes of the subject *and* are features of the object? This is not the place to clarify these contradictions in detail or to reconstruct the full history of the concept 'affordance' (particularly because other contributions in this volume address aspects of it). For our purpose it seems more productive to introduce a less known author who was a contemporary of Koffka and Lewin.

Jakob von Uexküll published his much-noticed book 'Theoretical Biology'[10] in 1920 and already in 1909 he introduced the term 'Umwelt'[11]. This phenomenal *lifeworld* of animals is species-specific and therefore different for each species, as each species reacts distinctively to different objects in its environment.[12] Refering to Immanuel Kant,[13] he argues that in the Umwelt of an animal exclusively those objects exist which can be perceived with the particular sensorium of that species and that for this species only these objects can have meaning at all. Although Uexküll rejected Darwin' s theory of evolution, his phenomenological inspired approach to the inner world (German *Innenwelt*) of animals gained wide influence to growing disciplines like animal psychology and ethology. For example, Konrad Lorenz underlines the relevance of learning processes for behaviour—but now, the animal acquires the 'invitation character' by exploratory action: "Jakob von Uexküll once said that all things in the 'world' (*Umwelt*) of animals are 'action things‹ (*Aktionsdinge*) (1909). This is particularly true of the objects with which an animal has made itself familiar through exploration, and has then 'laid ad acta' for later reference."[14] In this sentence, not just the behavioral scientist is speaking because Konrad Lorenz is a founder of *evolutionary epistemology* as well.[15]

Also in the context of affordances it is of special interest which knowledge is innate and which is only acquired through the experiences of the individual. That learning is mainly favored by two factors: First, the disposition of a biological observer system that every learning is subjectively experienced positively. Second, the disposition that this biological observer system is to be understood as a 'curiosity being,' as Lorenz calls it. From this wording, it becomes clear that these curiosity beings—be it humans or other animals—actively deal with their environments. By no means do they passively wait for an external impulse before responding to it (as the behavioristic stimulus-response scheme would provide). It is precisely this phenomenological perspective which places value on subjective experience that Konrad Lorenz already found in Uexküll. The latter refers to Kant, who explains the principle of the unrecognizability of the 'thing-in-itself.' Not only is the sensory equipment of a living being the reason why each species lives in its own Umwelt, which is fundamentally different from that of another species. In addition, there are the very different possibilities to act on this environment. The *perceptual actions* mentioned above also belong to these possibilities of action. Each of these perceptual actions can be understood as an

epistemic action, which resembles a question to the environment: If you do not ask, you will not receive an answer and thus far less information about the environment. The *effects of action* are an indispensable source of information that has been and is systematically underestimated by positivists. Many, if not most, aspects of things cannot be seen as long as the observer remains passive (think, for example, of the haptic qualities, the weight or the hardness of objects). Therefore, interaction with the environment is an essential method without which it is impossible to construct a comprehensive cognitive reality model. Gibson explicitely formulates the principle:[16] "We must perceive in order to move, but we must move in order to perceive." *Uexküll recognized this and formalized it in his 'functional circle,' thus laying an important foundation for biocybernetics.*

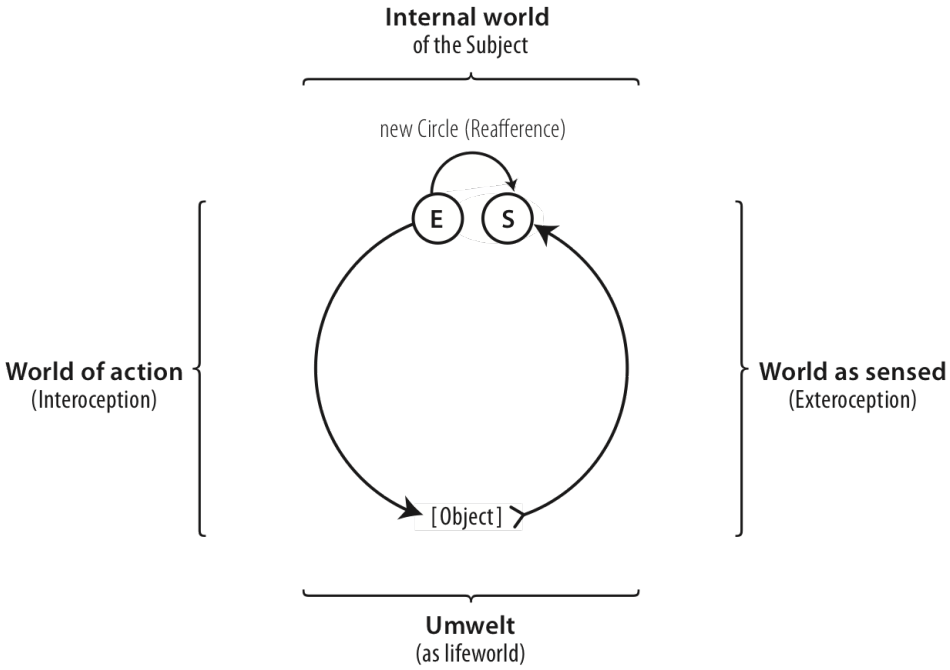

Figure 1: The structural elements in the 'function-circle' due to Jakob von Uexküll, 1926, 157
(Source: own depiction from Schwarzfischer, 2019, 306)

The *function-circle* expresses the theoretical design of Uexküll, on which the biocybernetics of the 20th century is based. Essential is the differentiation into four distinct areas:

[1.] The 'Umwelt' (as the subjective environment) is everything that does not belong to the observer system itself (but e.g. the newborn human does not yet know what belongs to him or her and what does not).

[2.] At the center of the 'world of action' (as the effector world) is what is known as *efferent* nerves (these are the descending nerve pathways that lead from the brain to the muscles and that are necessary for action, i.e. for interacting with the environment). Because it is part of the activity, the physical self-perception of the actor (the 'interoception') belongs to the world of action. The world of effects pursues implicit or explicit goals, the realization of which is to be understood as 'top-down processes.'

[3.] The bottom-up processes in the ›world as sensed‹ (as the receptor world) work up the sensory input—based on the *afferent* nerve pathways (which run from the sensory periphery to the brain and which are the medium for noticing the environment). This is the perception of the outside world (the 'exteroception').

[4.] In evolutionary and developmental terms, the 'inner world' is the most recent area because it encompasses the higher cognitive processes of mental probing and conscious reflection. However, the elementary basic structures are significantly older. Basal is, among other things, the principle of 'reafference,' with which it is possible to distinguish, for example, whether the world has moved or whether I have only performed an eye movement. (Thereby the efferent muscle commands are set off against the afferent sensor signals, which the word 'reafference' expresses). Even complex memory structures are further developments of what is called the 'new circle' in figure 1. All effectors are grouped there as (E) and the (S) denotes the sensors. Schwarzfischer further developed the model (2019, 307–308). Thus, an 'inner world' can also be attributed to a counterpart in the environment, if this counterpart behaves *non-trivially* (so that this counterpart can be attributed with the control of behavior by intentions).[17]

Two Fundamental Perspectives on Affordances: The Sensomotoric and the Ideomotoric Approach

In a way, Uexküll anticipates the 'pragmatic turn' in the cognitive sciences, as propagated by Andreas Engel, Karl Friston and Danica Kragic, 2015. This 'pragmatic turn' describes the paradigm shift from the 'sensorimotor approach' to the 'ideomotor approach.'

> [s.] The *sensorimotor* approach is based on traditional cognitivistic thinking, which assumes a (quasi-)linear *input-processing-output* scheme. Accordingly, the sensory organs are the input that is processed centrally in the brain, resulting in an output (which either consists of a motor action or in a cognitive perceptual judgement, e.g. in an aesthetic or ethical evaluation). Primary is always the perception, which then leads to a secondary action—hence the name 'sensorimotor approach.'[18]
>
> [i.] The *ideomotor* approach assumes an active observer, whose actions generate the observable phenomena as *effects of action*. For example, the infant recognizes only through its own movements (as 'ideomotor' means self-moving) what belongs to its body and what belongs to the environment. Similarly, observers only recognize the structured depth of the spatial arrangement when they act, as Gibson (1979, 123–125), shows with the help of flying birds. In general, according to the ideomotor approach, activity is primary and the perception of resulting action effects is secondary. Even the still undirected movements of an infant induce an input without which the development of higher cognitive structures would not be possible. This is called *embodied cognition* (because without physical action, cognition would not be possible) or *enactive cognition* (this is generating cognition because the activity itself generates action knowledge, relying on processes of self-organization rather than explicit knowledge or reflection).

This distinction is relevant for a comprehensive understanding of affordances, since two very different types of calls to action are evident: First, there are affordances to *react* physically to a given situation. This corresponds to the affordance concept in design, where real actions are triggered to change the situation (e.g. when a door handle has the affordance to open the door and enter the building).

This corresponds to an affordance to ›instrumental actions‹ as described above. Second, affordances to 'epistemic actions' (which do not aim to change the world) can be distinguished from those. Rather, they help to improve knowledge of the world. Information is not passively registered but actively *provoked*. Real interventions can be addressed as well as mental trial treatments or communicative inquiries in the social space.[19]

What exactly *provokes* an affordance that calls for action? It calls for interaction. But a concrete action (be it physical action, mental test treatment, or communicative simulation) presupposes a goal, which can be explicit or implicit. In the case of ›instrumental action‹ this goal represents a desired *state of the world*. In the case of the ›epistemic action‹, a *question to the world* is necessary, which is to be answered. In relation to the cognitive observer system three things can happen:

[1.] A stimulus in the perceptual field suggests bottom-up a *goal* that is being considered (e.g. a deviation from the original intention, as children with Attention Deficit Hyperactivity Disorder experience everywhere). Here something is suggested *as a goal*.

[2.] A perceived or imagined object may prove to be suitable as a *means* to achieve the goal that dominates the situation top-down (e.g. in an escalating marital dispute a cup is suddenly seen as a 'projectile'). Now the suitability *as a means* is determined.

[3.] In the case of 'epistemic affordance,' the adressing of a role in a means-to-purpose relation is not that easy. The form of a statement (as a propositional sentence), which corresponds to the two varieties of the 'instrumental affordance' in [1.] and [2.], does not do justice to it. Rather, something approaches the observer in the form of *a question*, which can be answered in the next step by an 'epistemic action.' Accordingly such an action cannot be *falsified* as it would be possible in a statement. As a question it can only be accepted or rejected.

Relevant in evolutionary and developmental psychological terms is that such questions can be implicit or explicit. This is significant because in early stages only an implicit question is possible as a motivation for exploration. A biologically founded curiosity thus becomes the basis for any further development. Gerald Hüther shows why ideomotor activity has priority, even though the movements at first seem more random than arbitrary:

> From about the 7th week of pregnancy onwards, it can be observed how the embryo swimming in the amniotic sac performs its first, still very uncoordinated movements. Initially, these are rather twitches, which are triggered by the contraction of certain muscles of the trunk and extremities. [...] From the very beginning, learning takes place in the brain by using and exercising the corresponding bodily functions. In the course of this long and complicated learning process, the embryo is enabled to move its trunk, legs and arms in an increasingly coordinated manner [...]. What is true for the central nervous control of the body muscles is equally true—although less clearly visible or measurable—for the formation of all those neural circuit patterns that are involved in the control and coordination of all other body functions.[20]

Even the initially random movement of the embryo induces action effects that gradually make it possible to derive a cognitive body schema (which is still unconscious or implicit or embodied). Without this self-representation, it would be impossible to consider oneself later as an acting subject during mental trial treatments. First, one's own body must be appropriated to the extent that reliable *prognoses* of movements (as *anticipations* of action effects) are possible. Because they are embodied, these actions are always perceptible to others. Every action (whether it is sensorimotor-reactive or ideomotor-proactive) is thus public. Consequently, the production of affordances and the reactions to them are always both: they are of epistemological-embodied-cognitive interest (because ideomotor) and of action-theoretical-cultural relevance (because public).

Epistemic Affordances in Every Gestalt Perception

The action-theoretical paradigm represented here can also be applied to those areas that traditionally tend towards a passive observer. How this increases the explanatory value is to be shown with the simplest possible example. Furthermore, all complex scenarios are composed of its basic processes.

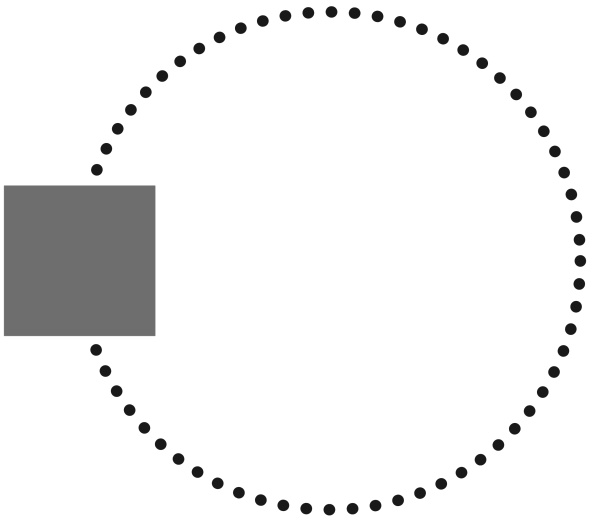

Figure 2: Simple example of a shape construction by the observer
(Source: own depiction from Schwarzfischer 2019, 83)

Why should we speak of a 'Gestalt-Construction' when we look at figure 2? The adult observer is usually not aware of any processes of ›construction‹. Rather, the ›content‹ of the image is immediately evident. But this impression is deceptive, because the supposedly given is an interpreted (and thus a *product*, something *made*) that differs considerably from what is actually seen (as sensor *data*). These deviations can be recorded quite precisely as processes of construction:

[1.] The 'circle' is no circle, because only an arrangement of single points can be seen in reality. Already the recognition of a regularity (a rotational symmetry) is put in by the observer as a cognition (based on unconscious conclusions).

[2.] The 'square' seems to lie on the circle and therefore hides a part of it. This also cannot be seen directly but is concluded. For the pixels of figure 2 are lying on one and the same plane (the paper), so there is no graduation of depth *within the figure*. This is added by the cognitive observer system by using probabilities that have developed and proven themselves in the empirical lifeworld (i.e. *outside of this illustration*).

[3.] This interpretation—that the 'square' lies on the 'circle'—creates another *fact* (done), which is not a *date* (given). The assumption that the 'circle' under the 'square' has the same regularity as the visible 'parts' is obviously a hypothesis and not a direct perception.

All three constructions, which were given here as examples, can be interpreted as unconscious cognitive processes on a very small scale. Such *microcognitions* underpin our entire life. All objects (not only the visual ones) are therefore to be understood as 'process results' of such microcognitions.[21] In adults, these processes run very fast, highly automated and unconsciously. They usually only become conscious when the results are unexpected, for example in the case of optical illusions, etc. The situation is different in infants and small children, where the learning processes are so slow that the external observer can, so to speak, 'watch them think in real time.' Here, ideomotor activity is slowly transformed into expectations of action effects, as described by Arvid Herwig, 2014. Enactive cognition plays the central role here because the action is primary and the ability to anticipate the *action effects* only gradually develops from it. This is exactly what happens unconsciously when we look at Figure 2. The ›spatial structure‹ of the elements is not seen but unconsciously calculated. These cognitive processes can be explained, as the contributions in Engel, Friston & Kragic, 2015, show. Furthermore, it can be shown that the enactive prior experiences are condensed to an aniticipative probability (which is called 'prior' in Bayesian reasoning). Each individual action changes this assessment depending on whether the expectation is confirmed or disappointed (which leads to the Bayesian 'posterior'—which is immediately used again as ›prior‹ for the next action). Without these interactions with the environment, learning that recognizes even the most elementary connections is not possible. In the famous study by Richard Held and Alan Hein

from 1963, young cats were raised in complete darkness. They were only able to see under controlled conditions (when light was on), forming two groups: One cat moved actively and the other cat was only passively moved by a device. The visual impressions in these bright learning phases were identical for both animals

because they moved in the same way through the same scene. But those cats that were only passively moved did not learn to see. They moved in the test phase as if they were blind. In relation to our example in Figure 2, this means that even the microcognitive processes have to be learned under specific conditions. We can speak of *active inference* (i.e. active inference based on action effects), even though there is no reflected consciousness in the narrower sense yet.

The reality construction of every human being is full of interpretation based more or less on real sensor data. The process model of Schwarzfischer from 2019, refines the ›function-circle‹ by Jakob von Uexküll and extends it into a multi-level model. The process results of the active inferences have a very different range in spatial, temporal and factual terms. Therefore, at least three such levels have to be differentiated.[22] The 'conclusions' of the first-level active inferences are again used as ›premises‹ for the second-level active inferences, etc. In our example from figure 2, this means that here at the lowest level a perceptual hypothesis is formed, which would be tested in early childhood by a *real action*. Later on, a *mental trial treatment* is sufficient, which, if routine is sufficient, is automated and unconscious (so that we think we can 'see' it immediately without any cognitive effort, but it is actually an immediate knowledge or remembrance).

In this context, *affordances to epistemic actions* can be defined as all uncertainties that cannot be deductively derived from the cognitive reality model. Wherever only probabilities are involved (i.e. when the hypothesis character indicates that it could be different), a cognitive process is set up to check or complete the uncertain information (as in the example in Figure 2). Two types of such cognitive processes are important here: *Forward modelling* takes the current perception and forms hypotheses about possible future developments (e.g. the expected action effects of epistemic or instrumental actions). *Inverse modelling* forms hypotheses about possible causes (e.g. the history of the current situation). Put simply, two types of *affordances to epistemic actions* can be distinguished: Either the question 'What for?' Or the question 'Where from?' is provoked. Figure 1 can illustrate this because it combines temporal and structural aspects. Thus the arrows in the 'function-circle' represent a direction and thus a time axis, because it is a succession of events. At the same time, the areas represent structural units (e.g. the efferent nerves of the 'action world,' the afferent nerves of the 'perception world' and the brain-based working

memory of the 'inner world'). All events in the ›action world‹ are spun forward to their possible/probable effects in the 'perception world.'[23] Every phenomenon in the 'perception world' can be investigated by inverse modelling for its causes in the 'action world.'

Affordances in *design* often refer to the direct request for an instrumental action, which can be understood as forward modelling (because the means has an affordance towards the end). However, the design of affordances to epistemic actions is also a design problem (but is traditionally more associated with criminology, pedagogy or science). Since these are less 'world problems' than 'knowledge problems,' forward modelling and inverse modelling are equally common. Forward modelling is intended to make it easier for the ›process customer‹ to operate in the desired direction. Inverse modeling is intended to strengthen the understanding of causes and interrelationships—and in the next step to support desirable actions. 'Desirable' does not mean that a extrinsical target is internalized without reflecting this. On the contrary, especially if the autonomy of the subject is to be promoted, its ability to act and reflect must be increased. This is done by improving cognitive processes, which we can formalize as forward modelling and inverse modelling. Autonomy is improved if the subject is enabled to understand even complex process chains across several links and to assess their probability. This makes it more difficult to manipulate this subject by the proverbial 'dangling a carrot in front of somebody' or by too clumsy falsifications of history—because the stages of reflection range from enactive anticipation of immediate effects of action to theoretical reflections of possible worlds. There, logical investigations are carried out as epistemic actions. Even if *in* these possible worlds no instrumental action can be taken, instrumental actions are conceivable in our life-world, which are supposed to turn a possible world into reality. Every design fulfills this definition. Consequently, non-existent objects can have an affordance to epistemic *and* instrumental actions.

Emotional Expression as Affordance and Epistemic Action

At first glance, all actions in social space are public and thus observable by others. This is true for instrumental actions that are actually performed. For epistemic actions, though, this applies to a limited extent (think, for example, of mental trial treatment) as well as for instrumental acts of omission (such as the selfish concealment of information). A complete catalog of affordances that encourage such actions is not feasible here due to a lack of space. However, in introductions one aspect is regularly neglected when the artifacts are in the focus of media sociology.[24] Especially the subpersonal processes of enactive cognition deserve our attention because they typically occur automatically and unconsciously. They usually only enter consciousness when the course of action is disturbed.[25] An example can illustrate this: We go for a walk—either in the forest or in a lively old town. What is the difference between dodging trees and walkers? In a busy shopping mall, our bodies are in dialogue; in the forest, only I react to the static trees. The mutual affordances when avoiding passersby cannot be traced back to a linear scheme of 'input-processing-output.' Here we are dealing with circular processes because both are obstacles for each other and react to each other. Subliminally, we perceive finest approaches of evasive movements and tend to the other side.

Most of the time, this is done without conscious reflection. From time to time, however, it happens that both of us try to sidestep the same side, which can lead to exhilarating choreographies. This happens when the affordances of one actor are not felt by the other to be clear or unambiguous enough. In a busy pedestrian zone, passersby can by no means retreat to fixed rules, as is usually the case in automobile traffic. Each regulation must be ›negotiated‹ as an individual case (in the double sense of the word). This is not a rare special case that only occurs when strolling. Rather, the reciprocal negotiation of who occupies which semantic role in a concrete situation represents the normal case. Epistemic actions are used for this purpose, which in turn act as affordances on the counterpart.

Thus, Wendy Wilutzky, 2015, argues for a changed understanding of emotions that are not only the expression of a state of mind (which would correspond to the linear scheme of 'input-processing-output'). At least as important is the function of emotions in shaping the current situation. In this context, the emotion or facial/bodily expression is not seen as the output/result/end of a social interaction but its input/tool/start in the sense of an epistemic action. The social counterpart is forced to react to this emotion—whereby ignoring it also

represents a reaction that does not break off the sequence of events but only changes it. If emotions are interpreted in this way, they represent affordances for communicative action from which it is almost impossible to escape. In addition, emotional expressivity itself is to be understood as an epistemic action because a situation that was previously unclear is clarified by forcing a response/reaction. Here, also, evolutionary and developmental psychological roots can be found that go back a long way. For example, teenagers provoke a reaction from others—both in their peer group and at home—by varying degrees of expressivity (from feigned coolness to slamming doors). Only from this reaction, teenagers become clear about which roles they can sensibly grab in this structure. The 'handbag dog' of our neighbors (biologically it is a ›German Spitz‹) does it in a similar way, when it yelps at everyone and reads from the reaction its position in the social ranking, which it did not know before.

Of course, these examples are not only epistemic actions because there is always an attempt to not only get to know the social structure but also to actively shape it. This becomes clear when the will to shape is as lacking as curiosity about the world. The absence of affordances in depression not only paralyzes the affected individual because instrumental and epistemic actions are greatly reduced. In addition, the depressive sends out much fewer signals through facial expressions, which leads to systemic distortions in his or her environment, as Keith Dixon and Hans-Ueli Fisch (1993, 30) quantitatively demonstrate. As a result, the depressive in turn stimulates little reactions because of offering few affordances. This lack of responsiveness of depressives is problematic from an evolutionary and development-psychological point of view since a central basis of *social cognition* thus fails. All primates use 'social referencing' to pass on semantic ratings (the so-called 'valence') to infants and toddlers through facial expressions.[26] The children always cast a casual glance at their mother, who reacts with an encouraging smile or a serious facial expression.This non-verbal response signals that a 'good' or 'bad' situation exists and regulates the child's behavior. In one study, the children moved the least far away when the mother made a 'fear face' and the furthest when the mother radiated 'joy.'[27]

Social referencing can therefore be regarded as epistemic action. Both parts of this dialogue of non-verbal questioning (as an epistemic action to obtain information) and mimic response (as an instrumental action to control the child) fulfill the criteria of affordance. This is because the behaviors are used to provoke a specific reaction by the counterpart. Thus, social referencing can be understood as an evolutionary and development-psychologically very old form of affordance. At the same time, it is an example of how social situations are shaped by affordances that do not require artifacts as carriers. Thus, artifacts are neither a specific feature of design nor of affordances—as claimed in the introduction.

Author Biography

Klaus Schwarzfischer, Dr. phil., began his career as a multimedia artist and communication designer. He later studied information design at Donau-Universität Krems and was awarded the *Young Academics Achievement Award* of the Society for Gestalt Theory and its Applications (GTA) for his master thesis in 2015. In 2019, he received his doctorate in media sciences from the University of Tübingen under supervision of Klaus Sachs-Hombach. Klaus Schwarzfischer's main research interests are cognitive semiotics, Gestalt psychology, design theory, and empirical aesthetics. In addition, he was a member of the advisory board of the German Society for Semiotics and head of the design section from 2005 to 2019. Relevant book publications (in German): *Reality as a Design Problem* (2008), *Transdisciplinary Design* (2010), *Integrative Aesthetics* (2014), *Empirical Aesthetics* (2016) and *Aesthetics of Reality Construction: How Are Competing Aesthetic (Design) Preferences Possible? A cognitive-semiotic approach* (2019). Email: ks@indukt.de

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Notes

[1] This connection was first presented by Schwarzfischer at a talk about ›A Systemsemiotic Approach to Design‹ at EAD06, 6th European Academy of Design in Bremen, March 29th 2005.

[2] Sauer, 2014, extends the arts to the wider scope of pragmatism. Whereas, Schwarzfischer, 2019, completely leaves behind the arts, when combining the act-theoretical approaches of Piaget, 1972, and Lorenz, 1982. The resulting account is plausible from phylogenetic as well as ontogenetic perspectives.

[3] Kirsh & Maglio, 1994, distinguish ›epistemic action‹ (which aim at a gain of knowledge about the world) and ›pragmatic action‹ (which target to produce a specific state of the world). From a semiotic point of view we better do not speak of ›pragmatic action‹ here because any action has pragmatic aspects. Therefore, I will call them ›instrumental actions‹ instead of ›pragmatic actions‹. This differentiation is relevant for ›design‹ as we noted above: Hence, any intervention is design. In technical terms, shaping the world means that we try to realize a target state—this means, we apply an ›instrumental action‹. To get the actual value (and to decide whether it is different from the target value) we need an observation (which is formally a measurement of any kind). This is an ›epistemic action‹ which can be very simple or rather complicated (e.g. as an *experimental design*). It shows that the distinction by Kirsh & Paul, 1994, is an analytical one, because in everyday life both types occur combined. For example, any experimental design (as an ›epistemic action‹) needs several ›instrumental actions‹ to be realized and to work.

[4] For example: Norman, 1988, 1993 and 2018; Jacob & Wisch, 2006; Humphrey, 2010; Fox, Panagiotopoulos & Tsouparopoulou, 2015.

[5] The cognitive scientist Norman, 1993: 139ff., analyzes affordances with respect to ›distributed cognition‹. He demonstrates how affordances are used to minimize cognitive load and user errors. The targeted anchoring of affordances in a situation is unburdening the user, why it is also called ›cognitive offloading‹—see Dror & Harnad, 2008, or Grinschgl et al., 2020.

[6] Gibson, 1966, 285.

[7] Lewin, 1926, 28and 59–62.

[8] Borsato (2021, in press); translation by Klaus Schwarzfischer.
[9] Gibson, 1966, 285
[10] Uexküll, *Theoretische Biologie*, [German Edition], 1920; Uexküll, *Theoretical Biology*, [English Edition], 1926
[11] Uexküll, 1909, *Umwelt und Innenwelt der Tiere*.
[12] Uexküll, 1934, 47–48, tries to reconstruct the ›first-person-perspective‹ of animals to be able to grasp their subjective reality: He speaks of the ›sitting tone‹ (which a basket has for a dog), the ›climbing tone‹ (which a ladder emits), and the ›beating tone‹ (which an object emits for someone looking for a weapon). This is clearly reminiscent of Koffka, 1935, 7: »To primitive man each thing says what it is and what he ought to do with it: a fruit says, ›Eat me‹; water says, ›Drink me‹; thunder says, ›Fear me‹, and woman says, ›Love me‹.« Who has taken over this affordance concept from whom can remain open here. Because of his phenomenological methodology and his closeness to Gestalt psychology, Harrington, 1996, has dedicated an entire chapter to Uexküll.
[13] Kant, 1781, *Kritik der reinen Vernunft*.
[14] Lorenz, 1982, 328. In the German version of this sentence, Konrad Lorenz, 1978, 259–260, speaks explicitly of ›Neugierwesen‹ (*curiosity beings*).
[15] Lorenz, 1978, *Behind The Mirror*.
[16] Gibson, 1966, 223
[17] This attribution means that these are non-trivial systems according to Heinz von Foerster, which provide different outputs despite the same input—see Foerster & Pörksen, 2002, 54–57.
[18] In the present context, the term ›sensorimotor‹ should not be confused with the term Piaget, 1972, 20–31, uses in his genetic epistemology for the first phase of life, which he also calls ›sensori-motor‹ In fact, however, Piaget is referring to what is called ›ideomotor‹ in more recent literature. The conceptual differentiation between ›sensorimotor‹ and ›ideomotor‹ was not yet established in Piaget's time, although the principle can be traced back to James, 1890, see Stock & Stock, 2004.
[19] Consequently, both ›instrumental actions‹ and ›epistemic actions‹ can occur in all three spheres, which the technology philosopher Hubig, 2006, 141–142 and 241, distinguishes: The cognitive *intellectual technique*, the physical *real technique* and the institutional *social technique*. Hence, all three areas are fields that can be designed-—and must.
[20] Hüther, 2017, 83–84 [translation by KS]
[21] See Schmidt, 2010, 104–105
[22] In the *lifeworld*, however, even finer differentiations are necessary, so that Schwarzfischer 2019, 317, proposes a ›normal version‹ of the process model with eight levels each in the top-down pathway (the world of action) and the bottom-up pathway (the world as sensed).
[23] This is the basis of ›reafference‹, as described by Lorenz 1982, 63, by reference to rats that are frustrated when the expected action effects do not occur although the action is performed.
[24] For example, see Zillen, 2008
[25] For more detailed information, please refer to the ›inquiry cycle‹ by Dewey, 1938. This can shed light on scientific problems as well as on everyday irritations in the course of the action. A visualization with detailed explanation can be found in Strübing, 2014, 43, and Schwarzfischer, 2019, 129–130.
[26] Höhl & Pauen, 2015, show that the social dimension already plays a major role in learning in infants (e.g. *joint attention* and *social referencing*, in which the observed facial expressions of the other person assign an object its valence). A ›fear face‹ of the mother assigns a negative valence to the object, whereupon the infant does not approach the object further. A mother's smile assigns a positive valence to the object and the infant continues to approach the object with encouragement. This observation disproves the common saying »Burned child shuns fire« at least in important parts. This is because the assumed direct interaction with the object does not have to have taken place at all since the assignment of the valence is already done at sight through *social referencing*.
[27] For details of this study see Klinnert et al., 1983, 67