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Affordance

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Affordance

Abstract
1. (n.) An **affordance** is an action possibility formed by the relationship between an agent and its environment (J. Gibson 1977; J. Gibson 1979). For any combination of agent or environment, any given affordance either exists or does not exist. There is no middle ground. The most inclusive definition of affordances considers only the physical possibility of an action occurring. An agent does not need to be aware of the afforded action, such as the affordance of opening a secret door. This definition is rooted in perceptual psychology and its primary source is *The Ecological Approach to Visual Perception* by James J. Gibson (1979).

2. (n.) An **affordance** may refer to a **perceived affordance**. Perceived affordances are a subset of affordances. A **perceived affordance** uses a more restrictive definition that requires an agent to be aware of the affordance, either through direct perception or experience. A perceived affordance is a possible action to an agent (Norman 1988). Unlike the traditional definition, a perceived affordance is primarily a relationship between an agent's cognition and the environment. This definition is commonly used within the humancomputer interaction (HCI) community.

3. (n.) **Affordance** may refer to how appealing an action possibility is to an agent, as in "this switch has affordance." While the other definitions are dichotomous, this definition implies a magnitude (continuum) of affordance. This usage combines the ease of perceiving and/or perceived ease of performing a possible action. Since this usage refers to one or both of these qualities, this form is unclear from a theoretical standpoint.

Keywords
Afforded Action, Action Possibility, Functional Affordance, Perceived Affordance, Affording

Comments
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Affordance(s)

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Synonyms

Afforded Action, Action Possibility, Functional Affordance, Perceived Affordance, Affording

Definition

1. (n.) An **affordance** is an action possibility formed by the relationship between an agent and its environment (J. Gibson 1977; J. Gibson 1979). For any combination of agent or environment, any given affordance either exists or does not exist. There is no middle ground. The most inclusive definition of affordances considers only the physical possibility of an action occurring. An agent does not need to be aware of the afforded action, such as the affordance of opening a secret door. This definition is rooted in perceptual psychology and its primary source is *The Ecological Approach to Visual Perception* by James J. Gibson (1979).

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Theoretical Background

The affordance is a theoretical construct that represents the potential for an action to occur between an agent and an environment. This "potential for action" is an existential relationship between an agent and an environment. In many cases, this relationship is simplified by considering only a part of an agent's environment as offering an affordance. An example of an affordance is the potential to open a door using a doorknob. "Opening by doorknob" affordance exists between an agent with hands and a door having a functional doorknob. No affordance exists if an agent lacks hands (and similar abilities) capable of opening the door or if the doorknob is broken. This oversimplifies an agent's environment; pulling a door open uses support from one's feet, for example. However, many affordances may be considered dyadic relationships between an agent and an object and these are the most commonly studied.

Originally, affordances were developed for studying perception. This is because when an agent perceives the world, it becomes aware of the ability to do certain actions- even if those actions are not occurring or might never occur. There is a need for this term because the potential for an action to occur is quite different than an action occurring and warrants its own construct. For example, a person learning that a closed door is "opening" is different than that it is "openable." The concept of the "affordance" succinctly describes the relationship that an agent has perceived, which is that a potential action exists.

Theoretical Underpinnings

The Gestalt school first published concepts similar to the affordance. Jon Von Uexküll described the "functional coloring" of objects in his discussion of how organisms might perceive the world in terms of its action possibilities (Von Uexküll 1920). Later work by Koffka describes the perceived meaning of objects in similar terms, effectively describing perceived affordances (Koffka, 1935). These initial constructs were limited because they tended to describe affordances as requiring perception and were dyadic between an agent and an object. Perceptual psychologist James Gibson introduced the term *affordance* in "The Theory of Affordances" (J. Gibson 1977). This definition, which was clarified in his later book *The Ecological Approach to Visual Perception* (J. Gibson 1979), defined an affordance as a relationship between an agent and its environment. This is broader than an agent-object relationship, since multiple parts of an environment might be important to performing a given action (ex. banging two rocks together). This extension allowed affordances to be stated independently of any particular agent or environment, making it a central construct in Gibson's work on direct perception and evolutionary perception.

Affordances were a central piece of Gibson's later work on direct perception (J. Gibson 1979). Direct perception theories posit that organsisms perceive the environment directly in terms of the actions it affords. For comparison, indirect perception theories typically propose that an agent must first develop an internal representation of the world based upon physical properties of the environment (Rock 1997). By stating perception in terms of affordances, Gibson's theory explained how an agent's perceptual capabilities can be tuned to guide an agent's behavior without requiring conscious analysis of an "inner world."

The concept of affordances helps examine ecological perception, which accounts for perception in an evolutionary and agent-based context. In this view, the role of perception is to enable beneficial action. Gibson stated that agent's competitive advantages will be determined by their ability to perceive beneficial affordances they have available (J. Gibson 1979). From an evolutionary standpoint, organisms will survive because their perception helps them to act when presented with stimuli. Gibson described how an agent could have an affordance to perform some action (such as eating bananas) and how its perceptual capabilities detect these affordances through invariant characteristics (i.e. yellow coloring). Gibson questioned: if an organism could detect actions using its senses (direct perception) then what is the benefit of a mental model that duplicates the sensory information into a new set of non-action constructs (indirect perception)? This supported Gibson's theory of direct perception, though it did not rule out the possibility of indirect perception as a complementary process.

Recent Theoretical Work

Theoretical work on affordances has been slowed by confusion about affordances and overloading of the term "affordance" (McGrenere and Ho 2000). The main alternative definition was introduced in *The Psychology of Everyday Things* by Donald Norman (1988). Norman's usage of affordances brought Gibson's theory to the design of user interfaces within the human-computer interaction (HCI) community. The text provided a theoretical basis for implementing user interfaces with perceptually salient affordances. Norman's usage in this text refers to perceived affordances, ones that an agent knows, and how these make certain actions salient. Unfortunately, Norman's terminology made affordances seem like a perceptual construct rather than an objective relationship. Norman later clarified his usage to be closer to the Gibson definition, but the alternative meaning had already gained widespread acceptance in this new community. Affordance can also indicate a property of an object which refers to a concept more akin to salience or utility, a third meaning. By this definition, a button could be said to "have affordance" in the same way it might "draw attention" or "have utility." This definition does not provide a meaningful construct for analysis and its inconsistent usage causes great confusion. While the definition of affordances has primarily found a consensus, these alternate definitions still cause confusion in some disciplines.

Formalizations have been a factor in building consensus about the definition of affordances. Affordances have since been formalized mathmatically by a number of formulations, including the Stoffregen (2003), Chemero (2003), and Steedman (2002) formulations. These formalizations define affordances symbolically, in mathmatical language. This makes them more amenable for experiment design and for computational implementation. Different formalizations utilize assumptions that make them alternatively useful for perception, planning, or concise representation.

Researchers have extended affordance theory beyond the classical view of affordances. Gibson's seminal work distinguished between perceived affordances and the more general definition of affordances. As affordances became a major topic in literature, additional classifications for affordances were created (Gaver 1991). Figure 1 shows the relationships between affordances and an agent's perceptual information. The x-axis determines if an affordance exists, while the y-axis determines if an affordance perceptually seems to exist. Figure 2 gives examples that fit these categories, for the possibility that a handed creature could open a door.

Figure 1: Categories of Potential Affordances

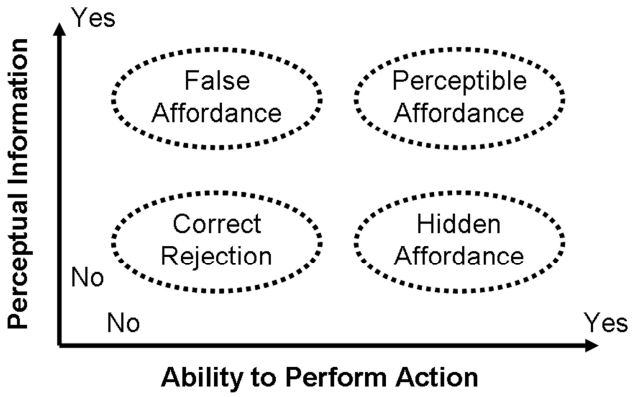
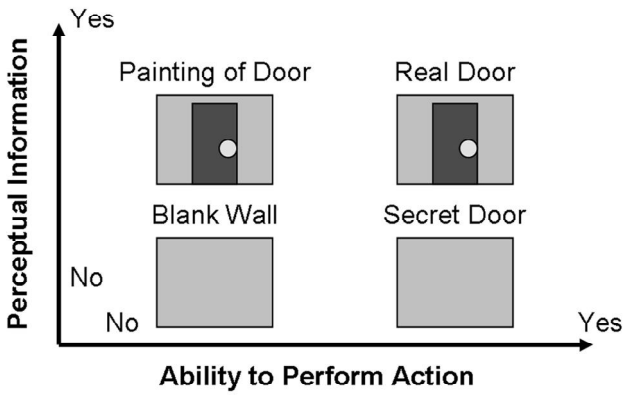


Figure 2: Potential "Openable" Affordances



Important Scientific Research and Open Questions

The study of affordances advance research in the behavioral science domain, as well as the applied science domain. In the behavioral sciences, affordances are used to study perceptual psychology, learning, and imitation. Perceptual psychology uses affordances within the realm of direct perception research. Gibson's work on direct perception laid the groundwork for a new branch of perception theory. This branch of perceptual theory does not consider the main component of perception to be the passive absorption of the environment. Instead, perception's main role is to guide action in a direct manner. Ongoing research attempts to build ontologies of affordances (ex. Sanders 1997) and to explore how organisms detect affordances (Gibson & Pick 2000).

Researchers build on this by studying how affordances are learned. Eleanor Gibson's work on affordance learning considers the primary learning process to be differentiation (E. Gibson 2000). Differentiation is a process where new affordances are learned by generating a distinction between one of its existing affordances with a new, more specific affordance- causing a more general action to be split into mulitple, more specific actions. Affordance discovery experiments expose infants and children to novel tasks under different conditions and examine how they learn. Researchers also study imitation and social learning of affordances. Animal imitation research studies if a particular animal is capable of affordance learning, such as Klein and Zentall (2003).

Applied science uses affordances in the fields of human-computer interaction, robotics, and agent based simulation. Human-computer interaction uses affordances to determine general principles of interface design that are optimized to allow the function of a tool to be obvious from its appearance (Norman 1988). Robotics researchers use affordance-based learning for situated robotics, such as autonomous vehicles or robot arms. Some of these robots can discover actions from its environment, either through exploration or imitation (Chemero and Turvey 2007). Agent based simulation uses simulated humans who interact with the environment through its affordances (Silverman, Johns, Cornwell, and O'Brien 2006). In this paradigm, agents and their environment are designed separately, with affordances defining the possible activities between them. Affordances also contribute to systems research. John Holland's work on complex adaptive systems contained in *Hidden Order* (Holland 1996) presents a mechanism for adaptation based upon affordances and the schema theorem, a proof based on the genetic algorithm.

While affordances have been a useful concept within theoretical, empirical, and applied disciplines they have fundamental open questions. These questions are connected to the meaning of abstractions, the origins of knowledge, dualism, and the mind-body problem (E. Gibson 2000). Others are primarily of a semantic nature, such as those addressed by Michaels (2003). A key question is how information about affordances is perceived and encoded (E. Gibson 2000). This relates to the origins of knowledge and the nature of memory.

Figure 3: Definitions of the Possibility of an Action

Scope of Possibility	**Associated Definition**
1.Physically Possible	-
2.Purposefully Possible	J. Gibson, 1979
3. Perceptible	Norman, 1988
4. Perceived	-
5. Deterministic	-

Other unresolved issues with affordances relate to their underlying constructs, such as the definition of an action. Actions exist as part of patterns of continuous behavior. This causes a classification problem of what should be considered an action. The determination that an action is "possible" is an even thornier issue, one that underlies the disagreements between the Gibson and Norman definitions. Figure 3 shows different scopes of possibility, which are shown from the most inclusive to the most specific. In the most inclusive definition an affordance is any action that could physically occur during the interaction of an agent and its environment, even unintentionally. Gibson's view requires the potential for intentionality when an agent acts on an affordance, implying that an agent must be either predisposed to certain behavior or change its disposition regarding to a behavior. However, the concept of potential intentionality is somewhat abstract and hard to define in real terms. The Norman definition restricts affordances further, limiting them to potential actions which are readily perceived within the environment. This requires an affordance to be either perceived (known) or perceptible (readily known from its appearance). Finally, a fully specified and deterministic view posits that the only possible action is the one that is going to occur. These are but a few debates ongoing about affordance theory, which will have implications for the meaning and practical uses of the concept.

Cross-References

→ Action Schemas

→ Affordances in AI

→ Cognitive modeling with simulated agents and robots

→ Human-Computer Interaction and Learning

→ Modeling and Simulation

→ Visual Perception Learning

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