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On possibilities for action:
The past, present and future of affordance research

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Abstract

We give a historical overview of the development of almost 50 years of empirical research on the affordances in the past and in the present. Defined by James Jerome Gibson in the early development of the Ecological Approach to Perception and Action as the prime of perception and action, affordances have become a rich topic of investigation in the fields of human movement science and experimental psychology. The methodological origins of the empirical research performed on affordances can be traced back to the mid 1980's and the works of Warren (1984, 1988) and Michaels (1988). Most of the research in Ecological Psychology performed since has focused on the actualization of discretely defined actions, the perception of action boundaries, the calculation of pi-numbers, and the measurement of response times. The research efforts have resulted in advancements in the understanding of the dynamic nature of affordances, affordances in a social context and the importance of calibration for perception of affordances. Although affordances are seen as an instrumental part of the control of action most studies investigating affordances do not pay attention to the control of the action. We conclude that affordances are still primarily treated as a utility to select behaviour, which creates a conceptual barrier that hinders deeper understanding of affordances. A focus on action-boundaries has largely prevented advancement in other aspects of affordances, most notably an integrative understanding of the role of affordances in the control of action.

Keywords: Ecological Psychology; Action Selection; Action Boundary; Perception-Action; Experimental Psychology.

James Jerome Gibson stressed that humans and other animals are active perceivers that live and move in a meaningful environment. The objects of perception and action, therefore, according to Gibson, are the meaningful relations between animals and their environment. Gibson called these relations *affordances*. He first introduced the term in 1966 as " (...) simply what things furnish, for good or ill" (Gibson 1966: 285) and further described the theory of affordances in his later work (Gibson 1977, 1979/1986) where affordances were defined as "a specific combination of the properties of its substance and its surfaces taken with reference to an animal"(Gibson 1977: 67)[2627]. The aim of the current review was to give an overview of the development of almost 50 years of research on affordances.

It was not until two important papers by Bill Warren (1984, 1988) were published before experimental research on affordances could really take off. In these papers Warren defined the role of affordances in the guidance of action and argued for the following sequence in the unfolding of an action: "...the intentions of the actor select an affordance to be realized, a corresponding mode of action by which to realize it, and appropriate laws of control to visually regulate the action" (Warren 1988: 341). More specifically, Warren argued that critical points of affordances may induce phase transitions between different modes of action-- involving stopping the first mode of action and starting another one--which are governed by different *laws of control*. In other words, according to Warren action modes map one-to-one into unique sets of control laws. Warren proposed that in this process of the action guidancetwo different problems need to be distinguished: First, the "*affordance problem*" of how organisms perceive what actions the environment affords in a given situation and on the basis of which action modes are selected; and second, the "*control problem*" of how optical variables regulate actions during a specific task.

Measuring Affordances

Gibson suggested that an affordance has to be measured relatively to the actor (Gibson 1979/1986: 127-128). That is to say, instead of using arbitrarily extrinsic units (e.g., meters) for environmental properties, affordances should be defined in terms of intrinsic metrics reflecting the animal-environment relation. Warren (1984) operationalized this idea in his study on the climbability of stairs. When taking a property of the animal as a standard for measuring an environmental property that is measured in the same arbitrarily extrinsic unit, the ratio of the two metrics is a dimensionless pi number that reflects the animal-environment relation. For instance, Warren found that

[26]Since the first introduction, different researchers and theorists have commented on and refined the definition of affordances. For instance, Turvey (1992) defined affordances as dispositional properties of the environment that are complemented by dispositional properties of animals, which he coined effectivities; Stoffregen (2003) argued that affordances should be regarded as properties of the animal-environment system rather than as dispositional properties; Michaels (2003) defined affordances as the actions permitted to an animal by environmental objects, events, places, surfaces, people etc.; Chemero (2003) proposed that affordances are relations between the abilities of animals and features of the environment.

[27]In the remainder of this paper we will focus on affordance research that follows the tradition started by Gibson (1979/1986) as the Ecological Approach (cf. Reed 1996).

independent of how tall people are, their action-boundary for the climbability of stairs (the critical height of a riser, such that lower risers are climbable whereas higher risers are not) is at a riser height of .88 times their leg length. Observers were remarkably accurate in the perception of this critical climbable riser height, and also of the optimal riser height (the riser height that could be climbed with least energy expenditure, at .26 times leg length).A biomechanical analysis showed that the number of .88 times leg length was not an arbitrary number: Warren measured the lengths of upper and lower legs, and established that upper leg length was .44 times total leg length, on average. Given this ratio, the number of .88 times leg length equals the distance from the foot to the floor when the upper leg is lifted maximally, touching the trunk. In the years following, the paradigm of looking for critical boundaries (and pi numbers) to study affordances was extended to a broad variety of tasks. To name a few examples, affordance research was performed on sitting (Mark 1987; Mark et al. 1990), passing through apertures (Warren &Whang 1987), passing under barriers (van der Meer 1997; Wagman&Malek 2008, 2009; Stefanucci et al. 2010), reaching (Carello et al. 1989; Rochat 1995), stepping over obstacles (Pufall & Dunbar 1992) and gaps(Jiang & Mark 1994) and walking-up slopes (Kinsella-Shaw et al. 1992).

Towards An Action Scaled Approach To Affordances

The early work on affordances was focused on, the so-called, *body scaled* affordances: affordances defined in terms of a geometric relation between the actor and the environment. However, as later researchers would argue, one's action capabilities are not merely body scale dependent, but are rather a combination of geometric, kinematic and kinetic characteristics. To address this idea, over the years, researchers have come up with experiments following an *action scaled* approach. For instance, Konzcak et al. (1992) reconsidered the situation of climbing stairs by taking into account not only leg length but also kinematic and kinetic factors such as hip flexibility and leg strength to calculate action boundaries. This action-scaled approach provided a better fit of the actual action boundary of maximal riser height than Warren's body-scaled measure. Perceived maximal riser height corresponded well with achieved maximal riser height, both in younger and older adults. The older participants were even more accurate in perceiving their action boundaries than the younger adults. Konzcak et al. (1992) argued that the reason could be that older people might have to be more accurate in order to avoid falling, while younger adults have the action capabilities to correct the results of a miscalculation.

Another example of an action-scaled approach are the studies of Pepping and Li (1997,1999, 2000) investigating the perception of action boundaries in the volleyball block. Pepping and Li showed that the action of overhead reaching and blocking in volleyball is, as in many sports situations, dependent on both geometric characteristics (reach height of the player) as well as kinetic characteristics (jumping ability of the player) and that participants accurately perceive their maximum overhead reach and block height. In order to investigate whether kinetic variables could be perceived, Pepping and Li (1999, 2000) designed a series of experiments in which they either changed the action capabilities, by giving the participants' a weighted belt to wear

which added their mass, or altered the kinetic requirements of the task by using different types of floors. The changes resulting in afforded actions led to an adaptation of the perceived action boundaries (Pepping and Li 1999, 2000).

Calibration And The Dynamic Nature Of Affordances

One's action capabilities can change over time and researchers have investigated whether people's perception adapts to these changing action capabilities. The process of recalibration to changed action capabilities was first shown by Mark (1987), in a study on sitting and stairs climbing. The participants of the study were wearing 10 cm blocks under their feet while judging their maximum seat height and their maximum riser height. Participants initially overestimated their action capabilities for stairs climbing and underestimated their action capabilities for sitting, consistent with the situation of not wearing blocks under their feet. After some experience with the blocks, they were able to recalibrate their perception of the new action boundaries for sitting and stair climbing, consistent with the change in their action capabilities: a process that could not be explained by a changed perception of the blocks, since participants consistently overestimated the height of the blocks.

As mentioned, Pepping and Li (1999, 2000) found that participants were able to rescale their perceived maximal reach when their action capabilities changed. Similar observations were made in the perception of affordances for standing on an inclined surface while changing the location (Malek&Wagman 2008) or the height (Regia-Corte &Wagman 2008) of the centre of mass of participants. When weights were attached to their body, participants were able to recalibrate to the changes in action capabilities, independently of whether they visually saw the surface or were able to haptically explore the inclination of the surface.

Most of the research on changed action capabilities involved familiar tasks for healthy adults. In contrast, a number of studies addressed the ability of participants to perceive affordances when using a wheelchair. The use of a wheelchair is a task most healthy adults are not familiar with (cf. Stoffregen et al. 2009). In a study by Higuchi et al. (2004) participants unaccustomed to the task of using a wheelchair judged the passability of apertures when rolling in a wheelchair. Systematic overestimation of their abilities occurred. After 8 days of practice passing through apertures the estimations improved, but the overestimation of the action capabilities did not completely disappear. The practice involved in this study only consisted of the task of passing through apertures, the task participants had to judge. Stoffregen et al. (2009) allowed some perceivers two minutes of self-controlled wheelchair motion before judging the minimum height under which they could pass in a wheelchair. Even when this practice did not involve the task of passing under, it still resulted in improved estimation of this action boundary compared to estimations of perceivers who did not practice. No improvement across trials occurredwhich implies that learning occurred prior to the judgments when allowed to practice and no learning occurred after the beginning of the judgment sessions (Stoffregen et al. 2009).

The Role Of Exploration And Movement In The Perception Of Affordances

The previous results raised the question of how the participants recalibrated their perceptual boundaries. In order to get more insight into this process Mark et al. (1990) had participants judge their maximum seat height (with and without the 10 cm blocks, see Mark 1987) while being, more or less, restrained in visual and physical exploration. When allowed to move (even just leaning forward and sideward and rotating their head) the observers were able to improve their estimations of maximum seat height. However,when exploration was constrained, less or even no recalibration occurred. Exploration was needed both in the condition with blocks as well as in the normal standing condition in order for recalibration to occur. The results suggested that participants had to determine their action capabilities each time before performing an action, even if they were familiar with the task (Mark et al. 1990).

The necessity of exploration (see for instance Mark 1990; Stoffregen 2009) implies that at least some movement is needed in order to pick up information about action capabilities. Oudejans et al. (1996) investigated the role of movement in the perception of catchableness of fly balls. They had participants judge whether balls were catchable in two different conditions. In a "stand" condition participants were not allowed to move while making the judgment. In a "move" condition they were allowed to move for a short period of time before having to judge the catchability of the ball. Even experienced baseball players had difficulties judging the catchability when not allowed to move during the task. The results demonstrated that movement was needed in order to perceive their action capabilities (Oudejans et al. 1996; but see Fajen et al. 2011). Additionally, Pepping and Li (2008) found that haptic exploration of the ground surface influenced the perception of the action boundaries in a jump-and-reach task. Although the perception of the action boundaries was not necessarily more accurate when the participants were allowed to haptically explore the surface (a constant overestimation of different surfaces occurred), the judgments were more consistent and less variable than the judgments without the possibility to explore.

Developmental Approaches To Affordances

In the previous part we addressed the process of recalibration of perceptual boundaries after changes in action capabilities. For example, in the studies of Mark (1987, 1990) and Pepping and Li (1999, 2000, 2008) the participants faced temporary changes in their action capabilities resulting from external factors (e.g. blocks under their shoes or increased mass of the participants). One of the more permanent changes in action capabilities is related to the process of growing older. Every day children have to adapt to changes in their action capabilities caused by development of skills and growth. Some of the classic studies on the development of visually guided locomotion in infants involved the detection of a visual cliff by infants. In these studies, infants balked at the edge of a visual cliff despite the presence of a Plexiglas table preventing them from actually falling (e.g., E. J. Gibson &Walk 1960, and Walk &E. J. Gibson 1961; for an overview of visual cliff studies, see, for instance, Adolph et al. 1993a and Adolph &Eppler 1998).

Multiple studies considered the perception of affordances of walking infants as well as crawling infants. E. J. Gibson et al. (1987) found a difference between walking and crawling infants in the perception of traversability of different surfaces. Walking infants showed longer initiation times and more exploration (both visual and haptic) when facing a deformable surface as compared to a standard surface. Crawling infants did not exhibit such differences. When given the choice between the surfaces, walking infants displayed a preference for the standard surface that afforded walking, whereas crawling infants did not exhibit a preference for one type of surface. This shows that infants detected the affordances for locomotion in a particular action mode (E. J. Gibson et al. 1987). The analogous conclusion can be drawn regarding infants' behaviour on slopes. In a series of experiments, Adolph and colleagues studied how walking and crawling infants adapted their locomotion when facing slopes of varying steepness (e.g., Adolph 1995; Adolph et al. 1993b; Eppler et al. 1996). Walking infants walked down a shallow hill of 10 degrees but slid down or avoided a risky steep hill of 36 degrees which are appropriate choices for the different degrees of the slant (Eppler et al. 1996; see also Adolph 1995). Also, Adolph's (1997) longitudinal study of infants' ability of crawling and walking on slopes showed that crawling infants gradually improved their judgments of risky slopes until these were near perfect in their last week of crawling. Next, after the transition from crawling to walking, all infants displayed a sharp decline in the accuracy of their judgments of risky slopes, after which their judgments improved again just as when they had been crawling. That is to say, infants became increasingly capable of adapting their mode of locomotion to the properties of the slant relative to their own locomotor proficiency, but this improved ability to judge slopes did not transfer from crawling to walking (Adolph 1997). Interestingly, when loading the infants with extra weight, infants changed their actions in accordance with this change in action capabilities by treating a slope that was a safe one in normal conditions as risky in the extra-weight conditions (Adolph and Avalio 2000).

Other studies focused on the influence of walking experience on the action boundaries of children. In a barrier crossing task (Schmuckler 1996) and a gap crossing task (Zwart et al. 2005) walking experience was related to the observed thresholds for barrier and gap crossing. Schmuckler (1996) suggested that skill and experience might play critical roles in tasks in which the actor is not an expert and that factors such as body size might become more important in familiar, well-practiced tasks.

Whereas many affordance studies have been performed on infants and toddlers as well as on adults, only few studies have looked at the developmental changes between infancy and adulthood. Plumert (1995) compared 6 and 8-year-old children with adults, and demonstrated differences in the accuracy between adults' and children's judgments whether they could perform different tasks (e.g. reaching and stepping tasks). Whereas adults overestimated their ability if it was just beyond their action capabilities, children also overestimated situations that were well beyond their abilities. Allowing the children to practice yielded improvements in the perception of the conditions that were well beyond their abilities for the 8-years-old, but not for the 6-years-old. Furthermore, 6-year-olds with less accurate judgments of their action capabilities had experienced more serious accidental injuries in their daily life (Plumert 1995).

The State Of The Actor In Relation To Perceiving Affordances

In the previous parts of this review, studies investigating different factors influencing action capabilities have been discussed. In their daily life, people also have to readapt to, often subtle, internal changes caused by, for example, fatigue or injury. Pijpers et al. (2007) studied the influence of fatigue on the perception of action possibilities for climbing on a climbing wall. Their results showed that in case the exertion led to a change in the actual action capabilities, perceived maximal reaching height changed accordingly. When the perceived exertion was less, however, no changes in the actual action capabilities occurred, and in that case the perceived maximal reach did not change. This indicated that people do not base their estimates of the action capabilities on the perception of fatigue per se, but on their actual action capabilities (Pijpers et al. 2007).

Emotions are another example of a change in the internal state of the actor. Bootsma et al. (1992) studied the effects of anxiety on the perception of reachability of approaching balls. Anxiety did not influence the perception of the affordance itself. That is, the location of the action boundary for reaching remained the same. This was in line with the expectations, since anxiety did not affect the action capabilities of the participants, the judgments should not be altered. However, as expected by the authors, more variability in the perception of the action capability occurred. The conclusion of the authors was that anxiety did lead to decreased accuracy in the pickup of the information that specifies the affordance of reachability of passing balls (Bootsma et al. 1992). The notion that anxiety can change action capabilities in some situations was shown by Pijpers et al. (2006), who investigated whether actual changes in the action capabilities of climbers induced by anxiety would lead to an adaptation of their judgments of their maximal reach in a climbing task. Indeed, the decrease in actual maximal reach in the high-anxiety condition did result in lower perceived maximal reaches. Subsequently, Pijpers et al. investigated whether the anxiety would also lead to differences in realizing the action possibilities. Participants did select other actions in the high-anxiety condition, but other factors than the perceived change in action capabilities might have contributed. Another experiment in the same study revealed that narrowing of attention caused by the anxiety might have played a role as well (Pijpers et al. 2006).

Social Affordances

Not only the perception of affordances for oneself, but more recently also the perception of affordances for others have become a point of interest. In daily life, people encounter plenty of situations that require interaction with other people. In some situations one even has to anticipate actions of others and, thus, on the action capabilities of others. Young children (three-to-five-years old) are already sensitive to the perception of action capabilities of others in the task of reaching (Rochat 1995). Rochat showed that children correctly judged the maximal reaching distance of an adult to be greater than their own maximal reaching distance. Whereas Rochat did not frame his

study in terms of action capabilities per se, Stoffregen et al. (1999) did. They considered intrinsic scales for the observed person as well as for the observer in the judgment of maximal and optimal sitting height of small and tall people. Observers in Stoffregen et al.'s study were able to base their judgments on the action capabilities of the different persons rather than on their own action capabilities. This implies that people are not only able to differentiate between the action capabilities of another person and themselves, but can also judge the difference in action capabilities between different persons (see also Mark 2007, for other examples).

As discussed before, the ability to recalibrate after a change in action capabilities is an important factor in the perception of affordances for oneself. In the case of the perception of affordances for others, the question is whether observers are able to recalibrate to the information specifying changed action capabilities. Ramenzoni et al. (2008) had people perform a reach-with-jump task to investigate recalibration in the perception of the action capabilities of other persons. The action capabilities of the observed person were changed by attaching weights around the ankles, which was either visually apparent for the observer or hidden underneath the person's clothes. Even when observers were not explicitly aware of the extra weight attached around the ankles of the person, they gave lower estimates of the maximal reach-with-jump as compared to the situation without the extra weight. Ramenzoni et al.'s results demonstrated that people are sensitive to a change in the action capabilities of others. This is impressive considering the fact that the observers did not actually see the person perform the reach-with-jump task, but only saw the person walking around.

In order to accurately judge affordances for others it matters what action the observer sees the person performing. Ramenzoni and colleagues (2010) compared the situation in which the person rotated the torso with the situation in which the person lifted a weight by squatting. The latter is an action related to the action of jumping whereas the former is not. Observing the person performing the nonrelated action did not yield an improvement in the perception of the action capabilities of the person; in contrast, observing the person performing the action related to the task to be judged did help to improve judgments.

Expertise might also play a role in the proficiency to judge affordances for others. Weast et al. (2011) addressed this issue by looking at the difference between basketball players and non-basketball players in the perception of sport-relevant (maximum standing-reach and reach-with-jump heights) and non-sport-relevant affordances (maximum sitting height). Basketball players were more accurate in the perception of the maximal jump and reach of others than the non-basketball players. Furthermore, they showed improvement in their judgments of the maximal jump and reach after exposure to kinematic information, whereas non-basketball players did not. Weast et al. suggested that this might be due to a greater sensitivity of basketball players to kinematic information reflecting the action capabilities of others.

Until now, we discussed studies on the perception of affordances for others, in which no interaction between the observers and observed people took place. Recently, also the affordances for joint action have become a point of the interest for study. For instance, the participants in the study of Richardson et al. (2007) judged whether they

would grasp planks of wood using one hand, two hands or together with another person. When comparing these judgments with actual performance, one-handed grasping, two-handed grasping, or two-person grasping could be mapped onto relevant body dimensions (i.e., the size of hands and arms). When scaling plank length, observed patterns in the transitions between using one or two hands were similar to observed patterns in the transitions between using two hands or two persons, at similar action-scaled ratios. These results show that people are not only able to perceive intrapersonal affordances but they are also capable of perceiving interpersonal affordances in grasping. Similarly, Davis et al. (2010) investigated the action boundaries of dyads walking through an aperture. For both dyads in which the observer took part as well as for dyads consisting of two other persons the observer's perceived action boundary for the dyad was smaller than the sum of the individual action boundaries. This indicates that observers were sensitive to the affordance for joint action, rather than just mentally adding the individual action boundaries.

An Alternative Approach To Affordances

The affordances research reviewed until here followed the approach as first introduced by Warren (1984,1988). At about the same time that this line of research originated, another approach, forwarded by Michaels (1988), combined the theory of affordances with work on stimulus-response compatibility in choice reaction times. Stimulus-response (s-r) compatibility refers to the degree to which a set of stimuli and associated responses are naturally related to each other. Michaels (1988) explored the relationship between s-r compatibility phenomena and the theory of affordances. Stimulus-response compatibility occurs when responses are faster for particular stimuli than for other stimuli. A well-known example is spatial s-r compatibility which is observed when the spatial arrangements of stimuli are responded to faster by certain spatial arrangements of responses (Fitts& Seeger 1953;or an overview of the ecological approach to s-r compatibility, see Michaels &Stins 1997). Michaels hypothesized that the detection of affordances might be manifested in the speed by which responses are made, thus "responses afforded in certain situations ought to be faster than responses not afforded" (Michaels 1988: 231-232). To test this hypothesis, a series of experiments was conducted which tested whether or not an object moving toward one hand would lead to faster responses with that hand than with the other hand, even though it might be closer to the other hand and,thus, have positional compatibility. The results revealed that participants reacted faster with the hand that could more easily intercept the object, providing support for the idea that spatial compatibility effects reflect the perception of possibilities for action. In a number of experiments, Stins and Michaels (1997, 2000) extended the approach by investigating the differences among response modes varying in level of compatibility. Different compatibility effects were found for the different response modes (pressing a button versus using a joystick: Stins& Michaels 1997; actual reaches versus button pressing: Stins& Michaels 2000).

Response times have been taken in account by other researchers as well. Fitzpatrick et al. (1994) had participants judge whether slants afford standing, and found an increase in response times and a decrease in confidence about the judgments the closer

to the action boundary. These results, together with the approach of Michaels (1988), led Smith and Pepping (2010) to consider movement initiation times, rather than judgment response times. They studied a reaching task, involving posting small balls through apertures of varying size and showed that judgment response times and reaching movement times were longer and more variable when approaching the action boundary. Since initiation time appeared to be highly sensitive to the location of the action boundary and optimal regions, Smith and Pepping argued that it offers a metric of affordance perception.

In most studies on affordances the perceived action boundaries are compared with the actual action boundaries. Pepping and Li (2005) hypothesized that the often-observed systematic errors between perceived and exact actual action capabilities might have been related to the means by which perceptual performance is measured. Therefore, in their study, both verbal as actual actions were used as response measures for judgment of overhead reachability. The results suggest that a perceptual judgment task is different than actually acting on affordances (Pepping & Li 2005).

Concluding Remarks: The Future

In this review we gave an overview of the affordance research in the past and in the present. The concept of affordances was introduced by J. J. Gibson, and most clearly so in his 1979 book entitled 'The Ecological Approach to Visual Perception' (1986/1979). Although research on affordances predates J.J. Gibson's conceptual work and can even be traced back to the seminal work of his wife E.J. Gibson (see E.J. Gibson 2002), the most influential empirical work on affordances can be traced to the pioneering work of Warren (1984, 1988) and Michaels (1988) Since then, the methods and approaches proposed by these studies have served as a guide to discovery. They have inspired many researchers to generate experiments in a variety of tasks, which resulted in a great amount of knowledge on different aspects of affordances. Most of the studies have continued to approach the study of affordances with similar methods -- that is, using discretely defined actions, and focusing on pi-numbers and action boundaries -- as first demonstrated in the classical studies on affordances (e.g. Warren 1984; Warren &Whang 1987; Mark 1987). Examples are the results of studies emphasizing the dynamic nature of affordances and those examining the ideas of recalibration, and perception of social affordances. The majority of studies focus on action *boundaries*. That is to say, they have aimed to establish whether some action is possible or not and whether participants are able to perceive this.

In this review we focused on what Warren called '*the affordance problem*' and we can conclude that most of the studies on affordances have followed a more or less traditional approach, using and extending the paradigms as first introduced by Warren (1984, 1988) which mainly focused on the perception of action boundaries. This focus on action boundaries leads to the impression that the primary behavioural utility for affordances is for the selection of behaviour, rather than the continuous control of action (for similar arguments see also Stoffregen 2000 and Smith 2009). This poses and important challenge to affordance research as results so far seem to emphasize a di-

chotomous view of possible and impossible actions which, obviously, is not sufficient to explain human behaviour. Given this shortcoming, what should the future of affordance research hold?

An answer to this question can possibly be found in the paper that was so instrumental in providing the methodological tools for most of the affordance research reported here. In his seminal 1988 paper Warren proposed that affordances have to be selected and that subsequently the mode of action and the laws of controls are selected. Furthermore, Warren argued that the affordance problem is directly tied to the '*control problem*' (Warren, 1988). A study on the control problem would focus on the laws of control by which our actions are being controlled. (i.e., 'information-based control'). From an information-based perspective the role of perception is to detect information in the ambient flow fields (e.g., in the optic flow) that can be used to guide movement according to a law of control (e.g., see Fajen 2007a). Examples of this information in the optic flow are the optical variable *tau* that specifies time-to-contact, and *tau-dot* (e.g., see Lee 1976, 1980)and optical acceleration for catching fly balls (e.g., see Chapman 1968; Michaels &Oudejans 1992; Todd 1981; Zaal& Michaels 2003). Historically Warren can be seen to have marked the start of separate research traditions into either the control problem or the affordance problem.

Research that links the affordance problem and the control problem as defined by Warren (1988) is scant. A noticeable exception is Fajen's (2005, 2007a) affordance-based control approach that sets out to show how action-capabilities play a role in the control of action. For instance, in the control of braking, Fajen (2007a) argued that people are sensitive to their action boundaries. This sensitivity is not captured in the typical information-based control explanation of keeping *tau dot* at a required value (e.g., see Yilmaz & Warren 1995). People are not simply using a control that can be framed in terms of (not) braking hard enough to avoid a collision, but people's control also takes into account their action. In other words, Fajen argues that the existing information-based approach fails to capture the limits of people's action capabilities. For example, the *tau-dot* model assumes that there are no limits to the amount of deceleration, but in real life actions these limits always exist (Fajen 2007a, for other examples on affordance based control see e.g. Fajen 2008, 2007b; Fajen&Devaney 2006, Bastin et al. 2010).

Fajen's work on affordance-based control seems a promising start to the unification of the affordance problem and the control problem. Note though, that also in affordance-based control the focus remains on the execution of discrete actions and on distinguishing possible and impossible actions when performing one specific task. Although the theory of affordance based control nicely shows the role affordances might play in the control of action, it remains relatively silent on the role of control in the perception of affordances. What is more, since its focus is on control, the research on affordances based control does not yet provide us with insight into how the affordance problem is solved; that is, as defined by Warren (1988), how an actor *selects* an affordance to be realized.

In summary, after J.J. Gibson's conceptualisation, Warren (1984, 1988) and Michaels (1988) have been instrumental in shaping the research on affordances. Reviewing the empirical literature, we conclude that research on affordances thus far seems to emphasise perception of action-boundaries in discrete actions which has prevented researchers from taking into account other aspects of affordances, most notably the link between affordances and the control of action. Warren's conceptualisation of the affordance problem and the control problem (Warren, 1988) has thus far not invited much research that looks at affordances and control in an integrated manner, with a notable exception of Fajen's research on affordance based control. Historically, we feel that Warren (1988) marks both the start as well as the future of research on affordances and that integrative study of affordances and control of action deserves to be put high on the future research agenda of Ecological Psychology.

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