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Events as changes in the layout of affordances

Anthony Chemero, Colin Klein, and William Cordeiro

Scientific and Philosophical Studies of Mind Program
Franklin and Marshall College
Lancaster, PA 17604, USA

Abstract: In a target article that appeared in this journal, Thomas Stoffregen 2000 questions the possibility of ecological event perception research. This paper describes an experiments performed to examine the perception of the disappearance of gap-crossing affordances, a variety of event as defined by Chemero 2000. We found that subjects reliably perceive both gap-crossing affordances and the disappearance of gap-crossing affordances. Our findings provide empirical evidence in favor of understanding events as changes in the layout of affordances, shoring up event perception research in ecological psychology..

Introduction

In the environment, people must often cross gaps of one kind or another; they walk across a river on a railroad trestle; they hop from one bank of a stream to another; they jump from a dock onto a boat as it pulls away. To get by in these situations, one must be able to perceive whether a particular gap affords crossing and, if so, whether it can be crossed by a casual step or by some other means (jumping, hopping, lunging, etc.). In this paper we describe the results of an experiment concerning the perception of affordances and events related to gap-crossing. The experiment described here was initially inspired by an exchange between Stoffregen (2000a, 2000b) and Chemero (2000) concerning the nature of events.

In his paper "Affordances and Events" (2000), Stoffregen makes a variety of points concerning differences between affordances and events as they are normally conceived by experimentalists. In particular, Stoffregen argues that events and affordances are not the same. Affordances are relations between the animal and its environment which have consequences for behavior. Events are normally conceived as static and dynamic properties of objects and surfaces; they are defined without reference to behavior, and are not scaled relative to action-relevant properties of the animal. Events are measured in standard, extrinsic units. When they have been measured at all, affordances are measured differently, typically by using unit-free π-numbers (e.g., by Warren 1984). Events are fully objective properties of the physical world, while affordances are not fully objective because they make sense only in the context of an animal-environment system. Stoffregen combines these points with the ecological truism that animals perceive affordances (Gibson 1979), and it follows fairly directly that events are not perceived at all. This, in turn, leads Stoffregen to question the value of event perception research.

In response to this, Chemero (2000) argues that Stoffregen has not shown that events are not perceived, but rather that events need to be re-conceived. It is quite natural from an ecological point of view to understand events as changes in the layout of affordances in the animal-environment system. Doing so would allow empirical research on events from an ecologically-oriented perspective, and would make that research safe from Stoffregen's criticisms. Chemero 2000 also suggests a way to measure events so described. Suppose affordances are measured in terms of π-numbers. If so, there ought to be critical values of π, beyond which particular affordances appear or disappear. Events, then, occur when values of π cross these critical points. In this paper, we will call these changes to the layout of the animal-environment system 'ecological events', in contrast to 'physical events', which are changes in action-neutral physical magnitudes.

The experiment described here is an explicit attempt to determine whether human subjects are able to perceive ecological events. The experiment is based on previous research on the perception of gap-crossing affordances (Burton 1992, 1993, 1994; Jiang and Mark, 1994; Mark, Jiang, King, and Paasche 1999; Cornus, Montagne and Laurent 1999). In the experiment, we examined whether subjects could accurately judge the point at which a widening gap no longer affords stepping across—that is, a simple model of a change in gap-crossing affordances, which would be gap-crossing ecological events. On the basis of previous research, and the hypothesis that ecological events are perceivable, we predicted that subjects would consistently and accurately perceive the critical values of π where gap-crossing affordances disappeared.

Method

Subjects

26 undergraduate students from Franklin and Marshall College (17 males, 9 females, age range 18-22 years, mean age 19.96 years) participated in the study. They all had corrected vision of 20/20 or better. Throughout the experiment subjects had binocular vision.

Devices and Materials

The experiment was run on a device with a stationary, level platform 52cm x 52cm raised 17cm off the ground. A second level platform 52cm x 52cm, also 17cm from the ground, sat on a track and could be driven by a stepper motor at a constant, experimenter-chosen speed. A hand-held button, when pressed by the subject, recorded the number of steps taken by the motor at the time of pressing. (See Figure 1.) This number of motor steps allowed the calculation of the distance that the moving platform had traveled. The accuracy of this method was confirmed periodically during the course of the experiment. Initially, the moving platform was in contact with the stationary platform, which we defined as a distance of 0 cm from the subject, which allowed for accurate comparison of distance for both the static and dynamic tasks below.

Procedure

Participants performed three different tasks: a step-across judgment task with a platform moving away from them, a step-across judgment task with static platforms, and an actual stepping task.

Tasks. After having their leg length (distance from lateral malleolus to the anterior-posterior iliac spine) measured, subjects were shown a short video demonstrating and explaining the difference between hopping, jumping, lunging, and stepping across a gap. A successful instance of "stepping across" was defined as follows: (a) The participant must always have had one foot on the ground; (b) the participant must have performed the motion comfortably, fluidly, and smoothly; (c) the participant did not step before or after stepping across; and (d) the participant must have had control of his or her balance and been able to remain stationary as soon as his or her lead foot reached the ground.

For the dynamic condition, subjects stood on the stationary platform and were given a hand-held button. Apart from being constrained to stay on the platform, subjects were free to move in any way. They were instructed to press the button when they judged that the second platform had reached the point at which they could no longer step across onto it. When the subject pressed the button, indicating that they could no longer step across onto the moving platform, the platform continued moving. They were told not to attempt to step across to the second platform during this part of the experiment, but that they would have to step the same distance in a later part of the experiment. The second platform was set to move away from the subject at five different speeds between 7.5 and 15 centimeters/second. Each speed was presented three times, randomly interspersed over a total of fifteen trials. The dependent variable for this task was the average distance between the platforms when the subject pressed the button indicating that she judged that she could no longer step across onto the moving platform. We will call this variable 'judged critical point'.

Preceding the dynamic condition, the subjects were presented with an equal number of practice trials across the full range of these speeds. The practice trials were identical to the dynamic trials, except that the platform stopped as soon as the button was pressed. This provided visual feedback to the subjects, allowing them to see the location of the second platform when they pressed the button. Although these trials were considered practice, data was collected on them in order to compare them to the actual dynamic trials.

For the static condition, participants stood on the stationary platform, while the second platform was manually set at various distances from the first. As before, apart from being constrained to stay on the platform, subjects were free to move in any way. The distance between the two platforms was pre-specified at randomly arranged five-centimeter intervals. Each time the platform was moved, the participant answered the question, “Could you step across this distance?” with either “Yes” or “No”. The participant turned around after each answer while the platform was repositioned, so were unable to see the platform being moved. The dependent variable for the stepping-across judgement task was the average over three trials of the largest distance between the two platforms that the subject judged they could step across. We will call this variable ‘judged gap’.

Subjects were then asked to step as far as they could on the floor, and their step was measured from a starting line on the floor to the heel of the foot which stepped. Following Mark *et al.* 1999, we determined actual stepping distance by measuring the distance the subject stepped on the floor, averaged over three trials. We will call this ‘actual step’.

Results

We found that mean leg length (0.88m; sd = .09m) was significantly shorter than both mean actual step (1.01m; sd = .18m) and mean judged gap in the static task (1.03m; sd = .20m). A variant of Warren’s unitless π numbers were used to characterize the affordance of static step-acrossability (Warren, 1984). π numbers, a common way of quantifying affordances, are ratios between properties of the environment and properties of the animal. These affordances will be characterized in two different ways: first, as the ratio between judged gap and leg length; second, as the ratio between judged gap and actual step. π_{leg} is the mean ratio between judged gap size and leg length.

$\pi_{leg} = 1.14$ (sd = 0.23)

The second possibly relevant π number is π_{step}, the mean ratio between judged gap size and actual step.

$\pi_{step} = 1.02$ (sd = .13)

T-tests confirmed that π_{step} was not significantly different from 1 (p=0.47), supporting the ecologically trivial point that subjects were consistently able to judge whether a gap afforded stepping across. More interestingly, the Pearson product moment test revealed higher correlations between actual step and judged gap than between leg length and judged step in the static condition (r=.81 vs. r=.38; significant at □ = .00069). This highly significant difference in correlations was confirmed by partial regression, which showed that the correlation between judged gap in the static condition and actual step with the effect of leg length subtracted is .77; while the correlation between judged gap and leg length with the effect of actual step subtracted is -.03. Thus, subtracting the variance associated with actual stepping ability leaves a very small (non-significantly different from 0) correlation between leg length and judged stepping distance. On the other hand, the correlation between judged and actual ability was quite high, even without the variance associated with leg length. We take this to indicate that actual stepping ability is more relevant than leg length in the perception of gap-crossing affordances; that is, this seems to imply that the animal-side variable in gap-crossing affordances is stepping ability. Because this is controversial,[1] we calculated critical values of π for the dynamic task using both leg length and stepping ability.

In the dynamic task, subjects pressed a button to indicate when they judged that they could no longer step across a gap onto a moving platform--that is, they were asked to judge when gap-crossing affordances disappeared. For this task, the mean distance at which subjects judged that the gap crossing affordance disappeared was 0.78 m (SD = 0.20). Therefore, subjects judged that the gap-crossing affordance disappeared at a distance considerably shorter than each of leg length (0.88 m), actual step length (1.01 m), and judged gap (1.03 m). A one-factor, within-subjects ANOVA showed no main effect for the various speeds ($F=1.54$, $p=0.198$), and Scheffe post-hoc tests confirmed that there was no significant difference between any two levels of the speed factor.

Using the judged critical point , we can also calculate critical values of π. As in calculating π-numbers for affordances, we can use either leg length or actual step to calculate these critical points. Using leg length, we get the following critical value of π:

$\pi_{crit,leg} = 0.89$ (sd = .20).

Using actual step, we get the following critical value of π:

$\pi_{crit,step} = 0.77$ (sd = 0.14).

Pearson product moment tests revealed high correlations between judged critical point and judged gap ($r = .85$) and between judged critical point and actual step ($r = .72$). We

[1] Gregory Burton suggests that it is illegitimate to claim that the animal is perceiving affordances in terms of ability, rather than body scale. We disagree. We see no reason to think animals do not pick up information about their abilities just as they pick up information about surfaces in the environment. Indeed, if effectivities (Shaw, Turvey and Mace, 1982) are the flip side of affordances, this must be what is happening, lest perception be indirect. Note that none of our conclusions rest upon this view of the

take this as strong evidence supporting our original hypothesis, namely that subjects would be able to perceive the disappearance of gap-crossing affordances. The high correlation of dynamic judgements with actual stepping ability supports the inference that subjects judged the gap to become uncrossable at a point reliably associated with their ability to step across the gap, and thus were able to perceive a change in affordances. As in the case of the static judgements, we also found that there was a much higher correlation between judged critical point and actual step than between judged critical point and leg length ($r = .49$). As above, we take this disparity in correlations to indicate that the disappearance of the gap-crossing affordance is perceived in terms of stepping ability, and not leg length. Given this, one should calculate the perceived critical value of π with stepping ability as the animal-side variable, yielding a a critical value of π of .77.

Discussion

We found that subjects did consistently perceive ecological events, changes in the layout of the affordances of the animal-environment system. The correlation between actual step (the relevant animal-side variable) and judged critical point was high (.73); the correlation between judged step and judged critical point was higher still (.87). We take this to provide abductive evidence in favor of the claim that events can be profitably understood as changes in the layout of affordances. The prediction that subjects would be able to perceive events as changes in the layout of affordances was generated as a result of the hypothesis that events are changes in the layout of affordances, and an experiment that shows that subjects can reliably perceive such

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relevant animal-side factor in perceiving affordances. We are currently conducting further experiments on the relevant animal-side experiment in the perception of affordances.

changes partially confirms this hypothesis. And so, with this experiment we have begun to answer one of Stoffregen's objections to Chemero's definition of events. Stoffregen (2000b) complained that there was no empirical evidence in favor of understanding events as changes in the layout of affordances. This experiment, we take it, provides one such piece of evidence.

We could not determine, however, why subjects judged that ecological events occurred at distances shorter than they judged they could step in the static task--the mean judged step was 1.03m, while the mean judged critical point was .78m. We have three ideas as to why this occurred. One possibility is that subjects were simply playing it safe; stepping onto an elevated, moving platform is more difficult and slightly more dangerous task than stepping onto a stationary one. Furthermore, because subjects thought they would have to step across onto the moving platform at a later part of the experiment, they may have systematically underestimated their stepping ability in the dynamic case. The second possibility is the occurrence of anticipation errors on the part of the subject. There is a well-established phenomenon in psychophysics known as the error of anticipation, where subjects estimating a limit in an ascending series will systematically underestimate the proper threshold (Woodworth and Schlosberg 1954). The moving platform is, in effect, an ascending series of possibly crossable gaps. Thus, the subjects may have committed systematic anticipation errors which our experiment was not designed to detect.[2] The third possibility is that subjects were actually judging that they could step onto the platform at the same distance as they judged they could in

[2] Errors of anticipation are typically avoided by alternating ascending series with descending series. We take it that the descending analogue of our task is not ecologically valid. There is little pressure to be able to detect precisely when one can step onto an approaching platform, as one will still be able to step onto it a few seconds (or minutes) later.

the static case, but that they were taking their stepping time into account. That is, subjects were pressing the button when they judged that they needed to start their stepping so as to land on the moving platform when it had reached the distance that could actually step. Although the ANOVA results for the speed factor did not support this, it may have been the case that the speeds were not sufficiently different to show an effect with so few trials[3]. If this third possibility is correct, the distance that subjects judge they can actually step is the same in the static and the dynamic tasks, with the difference accounted for by the time they judged their step would take.

General Discussion

Our results are also of theoretical relevance in light of the recent debate over the status of events and event perception research (Stoffregen 2000a, b; Chemero 2000). By showing that subjects can perceive ecological events, changes in the layout of affordances, we have provided the first piece of empirical evidence in favor of this way of understanding events. This responds to one of Stoffregen's objections to (Chemero 2000)—namely, that there is no empirical evidence in favor this view of events. Stoffregen has another objection, however:

> "Research has shown that we can perceive changes in the layout of affordances (e.g., Mark 1987). However, Chemero offers no argument for why the word *event*

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[3] Using the data collected from the practice trials, a 2-factor within-subjects ANOVA did show a main effect both for speed ($F=3.92$, $p<0.01$) and for the practice vs. actual factor ($F=4.22$, $p=.05$), suggesting that some slight effect may have occurred. However, we did not intend the practice condition to be an ecologically valid task (moving objects don't stop as soon as you try to step on them), and the data for the practice trials was correspondingly quite messy, calling into question the validity of its use. Further preliminary data from our laboratory, for a similar task using two widely separated speeds , found no effect for speed. Thus, this aspect of our experiment should hold up, although it still remains the case that the data above cannot rule out option number three.

> (with all its conceptual baggage) should be applied to these changes.”
> (Stoffregen, 2000b, 102)

We offer the following as an argument for applying the word ‘event’ to changes in the layout of affordances. Suppose Stoffregen’s arguments do effectively problematize event perception research that takes events to be changes in physical magnitudes in the environment. Given that, applying the word ‘event’ to changes in the layout of affordances saves ecological psychology from a worrisome fate. We submit that any theory that hopes to explain human behavior must have a theory of event perception. If we understand events as changes in physical magnitudes, ecological psychology has no way to account for the fact (and we take it to be a fact) that humans perceive events. Conceiving of events as changes in the layout of affordances gives ecological psychology to do empirical work on event perception with a good conscience.

Furthermore, taking events to be changes in the layout of affordances neutralizes another of Stoffregen’s criticisms of event perception research. Stoffregen (2000a) points out that there are good evolutionary reasons to think that affordances are perceived: perceiving opportunities for action directly allows an animal to act without complicated cognition, relating a perceived physical (that is, action-neutral) environment to current goals. Stoffregen argues that such considerations do not apply to events. But, of course, this is only true if one takes events to be action-neutral changes in the layout of the physical environment. Ecological events, on the other hand, ought to be perceived for all the reasons that affordances ought to be perceived. As (Chemero 2000) suggests, perceiving ecological events may play a crucial role for an organism learning about its environment. Perceiving, say, that a region did afford food-gathering but no longer does so is valuable, because the area come to have this affordance again. What’s more, perceiving ecological events may be a crucial prerequisite for learning how one can *change* the affordances in one's environment. It's not simply enough to respond to the different affordances of an apple on the tree and an apple on the ground in order to learn that one can knock apples down. An organism must also be able to perceive that a particular action on its part is linked to *changing* affordances before it can reliably incorporate such actions into its repertoire. But it's difficult to see how this could be done, unless the relevant *change* in affordances can also be perceived. Thus, if it is evolutionarily valuable to perceive affordances, it is also quite reasonable to think that there's value in perceiving the appearance or disappearance of these affordances.

Finally, studying events qua ecological events gives event perception research a useful working hypothesis—namely, that ecological events will be accurately perceived, whereas other physical events often will not be. Indeed, if this could be demonstrated it would stand as a feather in the cap of the ecologically-oriented researcher, for they more than anyone have the theoretical resources to explain why this should be so. Gibson suggests this in his own discussion of event perception:

> "Finally, it should be emphasized that some natural events demand or invite appropriate behaviors. Some have what I called *affordances* for animals, just as do places, objects, and other animals, and others involve a *change* in the affordance of the place, object, or other animal." (Gibson, 1979, 102)

While Gibson uses 'event' in the physical sense in this context, the import is clear. The relevant sorts of physical events for ecologically sound event research to study are precisely those which themselves afford something (i.e. a fire affords warmth) or which are changes in the layout of affordances. By focusing on this latter case, what we have been calling ecological events, we believe that event perception research can be integrated comfortably into ecological psychology.

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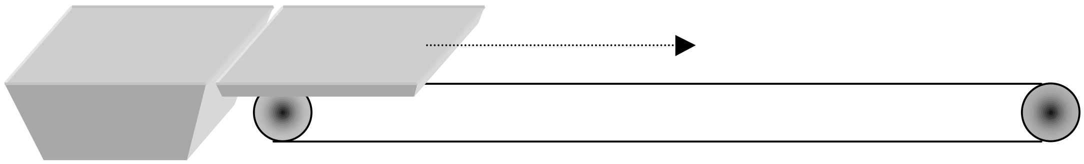
Figure

(a)



(b)

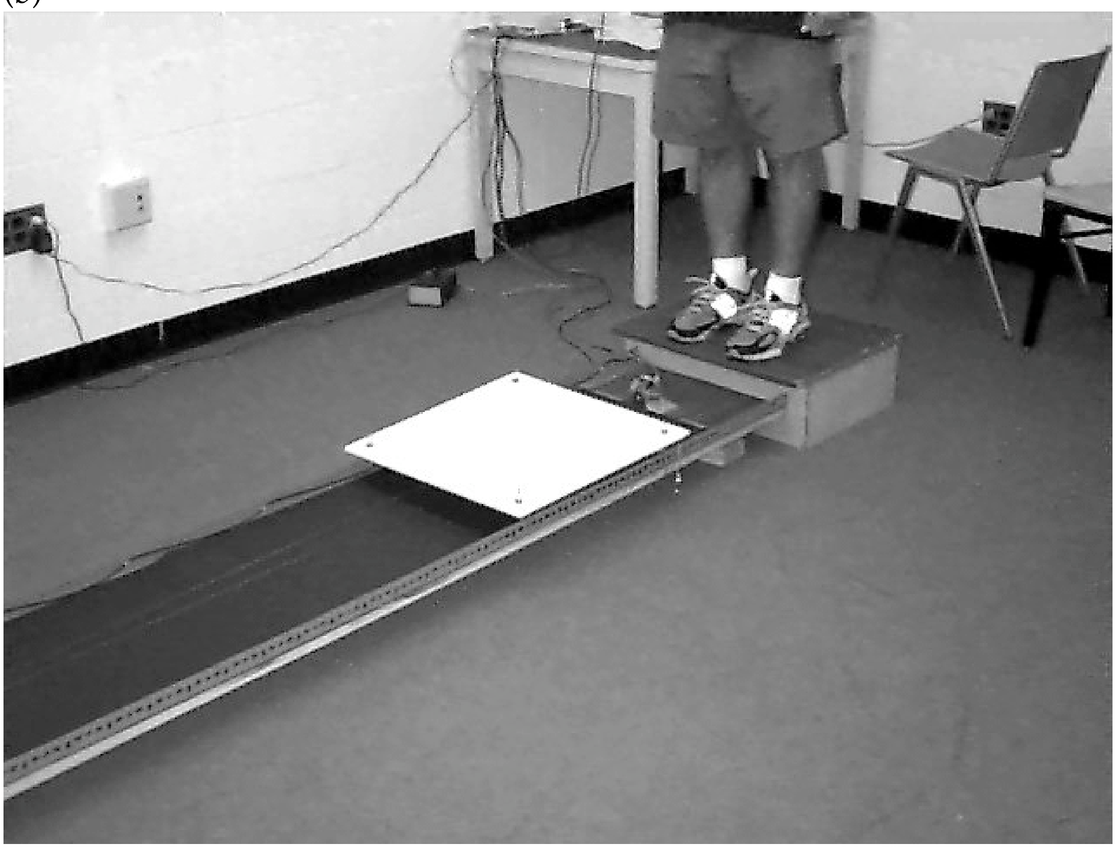


Figure 1. Figure 1 (a) shows a schematic diagram of the apparatus. Ss stood on the platform (at left), while the second platform (shown at two different locations here) moved away from them at variable speeds. Figure 1 (b) is an actual photograph of a portion of the apparatus