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Background

At any point in time there are a large number of options available to an organism. For example, a multitude of behaviors can be performed within a given environment at any time. Affordances are the relations between features of the environment and the characteristics of an organism that make particular actions possible (e.g., Gibson, 1979). Thus, successful action, such as locomotion through cluttered terrain, requires accurate perception of affordances.

Mark et al. (1997) showed that the choice of a particular action mode is constrained in part by the relative comfort of the possible action modes, which is determined in part by absolute maximum boundaries and preferred critical boundaries. They suggested that these two boundaries are different from one another; specifically, preferred critical boundaries may represent what Gibson referred to as a "margin of safety" (Gibson & Crooks, 1938).

A margin of safety can be thought of as a buffer that an actor provides herself when performing behaviors so as to avoid damaging or injurious behavior. This margin of safety may vary with the situation depending on an actor's intentions, environmental constraints, or task-based constraints (Mark et al.,1997).

Purpose

The current study explores whether Gibson's margin of safety is equivalent to the difference between an actor's perceived preferred critical boundary and their actual maximum critical boundary. Specifically, it investigates whether situational and task constraints influence the presence of an actor's perceived preferred critical boundary for crossing over a gap.

Hypotheses:

(1) It is predicted that participants will demonstrate a perceived preferred critical boundary that is different than the absolute critical boundary of stepping when transitioning from a step to leap (see Figure 1) while attempting to traverse gaps.

(2) It is also predicted that participants in the embedded condition will demonstrate the most conservative estimates of their abilities in comparison to participants in the focal and timed conditions. That is, the perceived preferred critical boundaries will occur at distances nearer the participant.

(3)Additionally, the perceived preferred critical boundary will coincide with an increase in safety ratings from safe to unsafe (i.e. average safety ratings above 3.0).

Figure 1. Examples of Step and leap actions. (Left): Stepping action : Actor keeps back foot on the ground while front foot is moving. (Right): Both feet are off the ground during the action.

Method

Participants

Data was collected from 45 undergraduate Clemson Students.

Procedure:

On each trial, a wooden stick is placed at a particular distance from the participant (See Figure 2). The participant then opened his or her eyes, and gave their response to the following questions:

1. Could you traverse the gap? Yes or No
2. How would you traverse the gap? Step or Leap
3. Indicate safety rating of action: 1 completely safe to 7 completely unsafe

Figure 2. Experimental set up. Participant stands with toes on white line. Experimenter moves stick to specified distances in randomized order. (Far Right): Embedded condition set up.

Conditions:

•Focal Condition: The participant could take as much time as needed to verbalize a judgment of the gap.

•Timed Condition: Judgment of gap and safety rating must be verbalized within two seconds of opening eyes.

•Embedded Condition: Participant was focused on distractor task of tossing a beanbag to score points after making judgment of gap and safety rating.

Results

A simple regression was conducted to determine if preferred perceived critical boundary means could be predicted from maximum step distances. The model was significant, $F(1,41)= 41.573$, $p<0.001$, yielding an $r^2=0.503$ (See Figure 3).

Another simple regression was conducted to determine if mean safety ratings could be predicted from proportion of actual stepping distance. The model was significant, [$F(1, 502)= 532.835$, $p<0.001$], yielding an $r^2=0.540$.

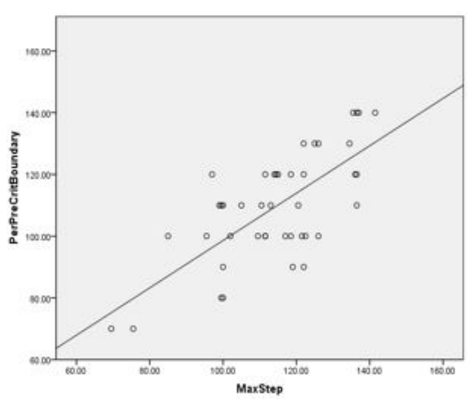

Figure 3. Mean perceived preferred critical boundary (cm) as a function of max stepping distances (cm).

This regression was then divided by each condition. The regression results for each condition can be seen in Table1, along with their slopes and intercepts. An ANCOVA was used to determine if there were any differences between the three conditions, it was not significant ([$F(1,449)=0.443$; $p=0.506$]. This can be seen in Figure 4.

Condition	R^2	Slope	Intercept
Focal	0.485*	0.625	44.031
Timed	0.590**	.748	17.784
Embedded	0.411*	0.893	9.314

$p<0.05$* $p<0.001$**

Table 1. Regression Coefficients for the three conditions.

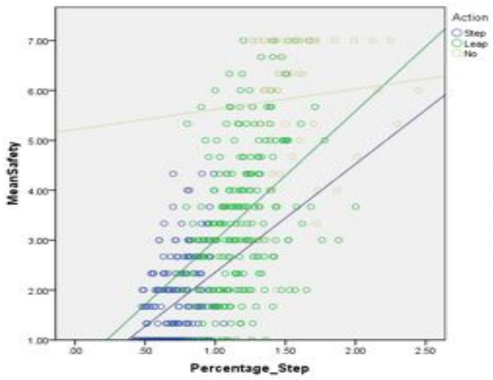

Figure 4. Action Judgement regressions of Percentage Step predicting Mean Safety ratings.

A one-way ANOVA was conducted to compare the condition types (Focal, Timed, and Embedded) with the ratio between actual stepping distance and perceived preferred critical boundary. There was no significant difference of ratio values between the different condition types [$F(2, 26)= 0.624$, $p=0.563$].

Post hoc comparisons indicated that there was a significant difference between the focal condition ($M=.998$, $SD=0.104$) and the timed condition ($M=0.908$, $SD=0.103$; $p= 0.027$) as well as a difference between the focal condition and embedded condition ($M=.982$, $SD= 0.129$; $p=0.039$). However, there were not significant differences between the timed condition and the embedded condition ($p= 0.811$).

Discussion

Taken together, these results indicate that when the demands of a task allowed for perception of gap traversability to remain a perception-action task, participants exhibited a 'margin of safety' in their judgments. Additionally, participants exhibited an increase in safety ratings once gap length surpassed participants' actual maximum stepping ability.

These findings suggest that organisms exhibit a margin of safety when given the freedom to act in an unconstrained manner.

Future research should investigate the potential for manipulating an actor's perceived critical boundary, perhaps through training and calibration.

References

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