Effects of Orientation on the Perception of Affordances in Wheelchairs

Stephanie M. Motiff, Molly K. Watkins, Yawen Yu, & Thomas A. Stoffregen
Affordance Perception-Action Laboratory, School of Kinesiology
University of Minnesota, Minneapolis, MN 55455

Background

One of the central principals of the ecological psychology approach to perception and action is that perception is an act; perception depends upon movement (movement of receptors, limbs, entire body).

Movements utilized for the perception of affordances (relations between properties of the environment and properties of the organism) are referred to as exploratory movements.

Stoffregen et al. (2009) found that exploratory movements of the head and torso were related to the accuracy of judgments about opportunities for wheelchair locomotion. Recent research found that a causal relationship exists between exploratory movements and the accuracy of affordance judgments, supporting the principle of ecological psychology (Yu et al., 2011).

Exploratory movements can be directly related to the act in question (taking a step to perceive the ability to catch a ball [Oudejans et al., 1996]), or not (body sway providing information about their ability to sit/climb [Mark et al., 1990; Stoffregen et al., 2005, 2009]).

In this study we sought to expand upon this previous research and further understand the ways in which the accuracy of judgments is a function of task and body orientation. Will movements in directions which correspond directly to the directions of a task be relevant and necessary for accurate judgment?

By monitoring head and torso movement while participants seated in contrasting orientations judge whether they can pass through a given aperture, we hope to learn more about the ways in which movement skills support accurate perception of affordances.

Objectives

- Evaluate the accuracy of judgments as a function of task and body orientation.
- Determine the differences in head and torso movement as a function of task and body orientation.
- Determine whether patterns of movement are related to the accuracy of judgments.

Participants

48 healthy adults (12 participants in each condition) with no prior wheelchair experience participated in this study. Participants were primarily college students.

Design & Procedure

Practice Session:
- Two minutes of wheelchair practice prior to judgment session.

Judgment Session:
- Motion sensors were attached to each participant to track head/torso movements while making judgments.
- Each participant was randomly assigned to only one of the 4 experimental conditions and completed 12 trials.
- We manipulated wheelchair orientation (directly facing apparatus/perpendicular to apparatus) for each of the judgment conditions; therefore, there were 4 experimental conditions: apparatus door orientation forward (ADOF), apparatus door orientation to the side (ADOS), apparatus blind orientation forward (ABOF), and apparatus blind orientation to the side (ABOS).

Condition		Orientation	
		Forward	To the Side
Judgment Apparatus	Door	ADOF	ADOS
	Blind	ABOF	ABOS

- Difference scores were computed as the difference between actual and perceived PH_{Min} and PW_{Min}. A smaller value of difference score represents more accurate judgment.

Apparatus

Wheelchair

- Standard non-motorized wheelchair that could be manually propelled forward/backward during practice.
- During judgment trials wheelchair was locked in place 3.6m from apparatus.

Figure 1: Door Judgment Apparatus

(a)Adjustable moving door that opened/closed via a mechanical motor. (b)The experimenter used a remote to open/close the door. A tape measure was attached to the door frame to indicate the passing width.

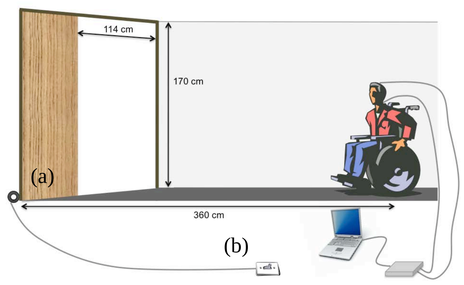
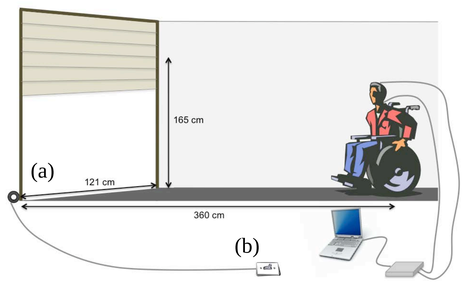


Figure 2: Window blind Judgment Apparatus

(a)Adjustable window blind that moved up/down via a mechanical motor. (b)The experimenter used a remote to raise/lower the lower bar of the blind from 1.0m to 1.65m above the floor. A tape measure was attached to the blind indicating the height of the blind.



Current Results

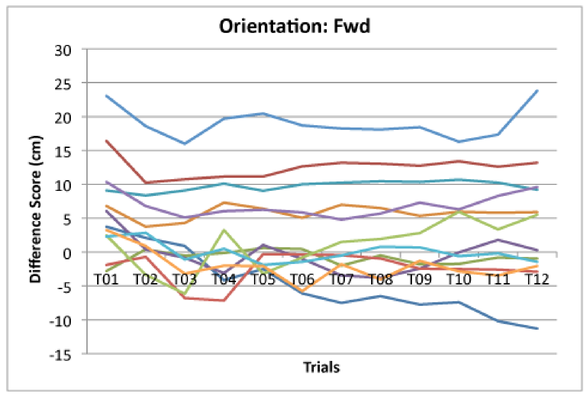


Figure 3: **Twelve individual participants' judgments (facing forward)**

Difference score = perceived PW_{Min} - actual PW_{Min}

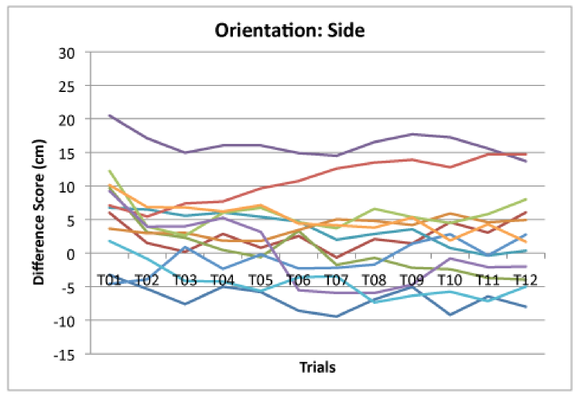


Figure 4: **Twelve individual participants' judgments (facing side)**

Difference score = perceived PW_{Min} - actual PW_{Min}

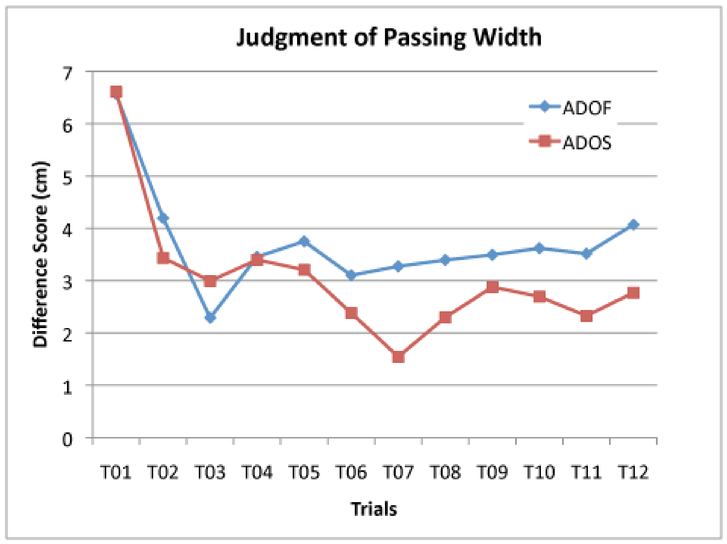


Figure 5: Mean judgments (difference scores) for participants facing forward (ADOF) and sideways (ADOS)

- Data from repeated measure ANOVA with one within-subjects factor (trials), one between-subjects factor (condition)
- Effect of CONDITION on judgment data: $F(1, 22) = .062$, $p > .05$ (accuracy of the perceptual judgment did not differ between the groups of people facing forward and facing side)
- Effect of TRIALS on judgment data: $F(11,12) = 2.440$, $p > .05$ (accuracy of judgments did not change across trials)

Conclusion

- Current results regarding condition (door only) show no significant effect on judgment data; accuracy of the perceptual judgment does not differ between participants who faced forward and participants who faced to the side while making their PWmin judgments.
- Current results regarding trial effect (door only) found no significant effect of trials; accuracy of judgments does not change across trials.

Future Work

- Analyze movement data from door apparatus
  - -Examine head and torso movements and their effects on judgment accuracy
- Analyze data from trials using the window blind apparatus
  - -Find judgment time intervals for each trial
  - -Record distance movements for head/torso during each trial (in cm)
  - -Record perceived PHmin and determine accuracy of each trial
  - -Examine effect of orientation on judgment accuracy
  - -Examine head and torso movements and their effects on judgment accuracy
- Compare and contrast results from door and blind apparatus
  - -Does the effect of orientation differ?
  - -How do movement patterns differ?
  - -How does accuracy differ?

References

Oudejans, R. R. D., Michaels, C. F., Makker, F. C., & Dolne, M. (1996). The relevance of action in perceiving affordances: Percep2on of catchableness of fly balls. Journal of Experimental Psychology: Human Perception and Performance, 22, 879-891.

Stoffregen, T. A., Yang, C., Giveans, M. R., Bardy, B. G. (2005). Affordance judgments and nonlocomotor body movement. Ecological psychology, 17(2), 75-104.

Stoffregen, T. A., Yang, C.-M., Giveans, M. R., Flanagan, M., & Bardy, B. G. (2009). Movement in the perception of an affordance for wheelchair locomo2on. Ecological Psychology, 21, 1-36.

Yu, Y., Bardy, B., G., & Stoffregen, T. A. (2011). Influences of head and torso movement before and during affordance perception. Journal of Motor Behavior, 43, 45-54.

Acknowledgements

Sponsored by the UROP and URS programs.