Perceptual biases in biological motion perception and other depth-ambiguous stimuli

Nikolaus Troje, Queen's University, Kingston, Canada

BIO MOTION LAB
www.biomotionlab.ca

Queen's UNIVERSITY

INTRODUCTION

Depth-ambiguous figures such as Necker cubes, point-light displays, silhouettes, or stick figures provide the visual system with two solutions which are more or less equally likely.

Here we document and quantify a number of systematic biases:

The facing bias

- Point-light walkers are perceived to walk towards the observer more often than away (Vanrie et al. 2004).
- The facing bias seems to depend on the sex of the walker (Brooks et al. 2008)
- We don't know whether it is dependent on motion at all or if we see it with static displays, too.

The viewing-from-above bias

"It is well known that the cube front side bottom is the preferred initial percept of most observers ..." (Kornmeier et al. 2009)

- While many are aware of it, to my knowledge it has never been described explicitly (please correct me if I am wrong and point me to references!).
- Well, maybe there is one paper (Mamassian & Landy, 1998)

The clockwise bias

- The perceived direction of rotation of a depth-ambiguous figure also depends on the chosen percept.
- An informal, internet-based poll finds that observers tend to see a spinning silhouette rotating more often clockwise than counter-clockwise
- Seems to work against a left-to-right bias which has been reported in other contexts (e.g. Spalek & Hammad 2005)

METHODS

Design

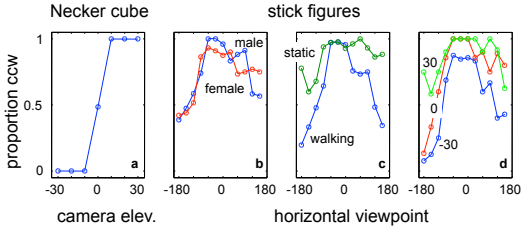
- Presentation Time: 0.5 s
- ITI: 2 s
- Walker gender: -5, -2.5, 0, 2.5, 5 z-scores
- Walker speed: static, dynamic
- Horiz. viewpoint: 0, 30, 60, … , 300, 330 deg
- Camera elevation: -30, -20, -10, 0, 10, 20, 30 deg

Procedure

- Each subject ran 1000 trials
- All walkers are stick figures
- 20% of the displays show cubes, the rest walkers
- Task: Is the figure rotating clockwise or counterclockwise?

RESULTS

Example data (subj. MH)



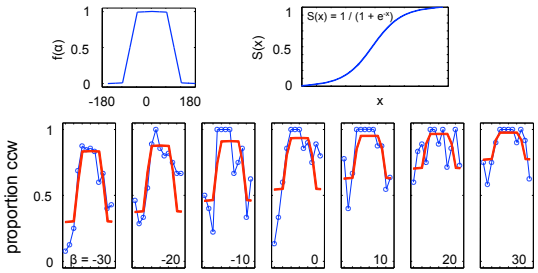
- For Necker cubes, we find a very pronounced viewing-from-above bias (Fig. 1a)
- We see a reasonable facing-the-viewer bias, but it does not seem to depend on the gender of the walker (Fig. 1b)
- Facing bias is stronger for dynamic than for static figures (Fig. 1c).
- Masked by the facing bias, we still see a small viewing-from-above bias (Fig. 1d)
- We see a substantial ccw bias for the stick figures (Fig. 1b-d)

A generalized linear model

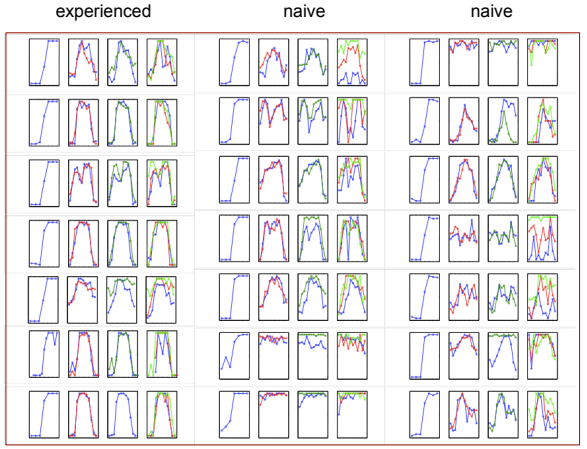
$$r(\alpha,\beta) = S[a + b\,\beta + c\,f(\alpha) + d\,g\,f(\alpha) + e\,m\,f(\alpha)]$$

r: rate of ccw responses
α: horizontal viewpoint
β: camera elevation
g: gender of the figure
m: static/dynamic

a: ccw bias
b: viewing-from-above bias
c: facing-the-viewer bias
d: effect of gender on ftv bias
e: effect of motion on ftv bias



Data from 21 subjects: 7 experienced, 14 naive



	ccw (*a*)	vfa (*b*)	ftv (*c*)	gender (*d*)	motion (*e*)	
mean:	0.772	0.024	1.310	0.065	0.320	stick figure
sem:	0.217	0.006	0.236	0.022	0.156	
p:	**0.0020**	**0.0004**	**0.0000**	**0.0069**	0.053	
diff:	-0.552	-0.010	1.525	0.102	0.518	
p:	0.240	0.407	**0.0007**	**0.022**	0.120	
mean:	0.464	0.179	-0.006	-0.006	0.137	Necker cube
sem:	0.101	0.006	0.041	0.022	0.095	
p:	**0.0002**	**0.0000**	0.887	0.784	0.165	
diff:	-0.396	0.000	0.006	0.002	0.121	
p:	0.065	0.984	0.948	0.964	0.560	

Here, we test whether the five different model parameters are different from zero. We also test for differences between naïve and experienced observers.

SUMMARY & DISCUSSION

- We find a general ccw bias (reading direction?)
- Very prominent viewing-from-above bias for cubes
- VFA not quite as strong for stick figures
- Stick figures are dominated by facing bias
- FTV bis depends on figure gender: Stonger for male than for female figures
- Depends also on experience: Increases with familiarity with figures

REFERENCES

Vanrie, Dekeyser, Verfaillie (2004) Perception 33:547 – 560
Brooks, Schouten, Troje, Verfaillie, Blanke, van der Zwan (2008) Current Biology 18:R728-729
Kornmeier, Hein, Bach (2009) Brain and Cognition 69:138–147
Mamassian & Landy (1998) Vision Research 38:2817-2832
Spalek & Hammad (2005) Psychological Science 16:15-18

Contact: troje@queensu.ca