‘Like a rolling stone’: naturalistic kinematics influence tracking eye movements

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Background

Observers implicitly use their knowledge of object kinematics in the real world to time the interception of free-falling objects [1] – i.e. they take acceleration due to gravity into account. Does this generalize to more complex visual kinematics?

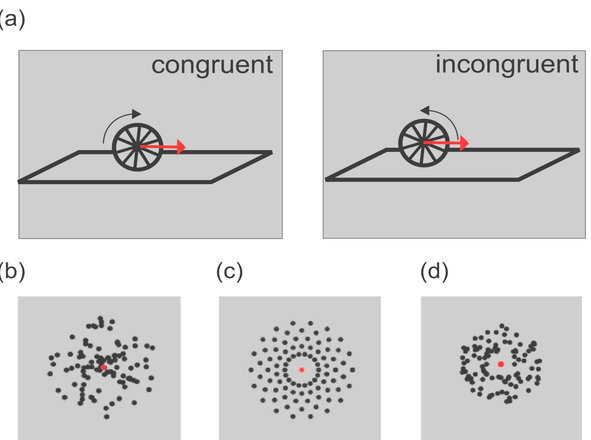
Research question

Are we better at tracking objects whose combination of rotation and translation corresponds more closely to what we encounter in the real world?

Materials and Methods

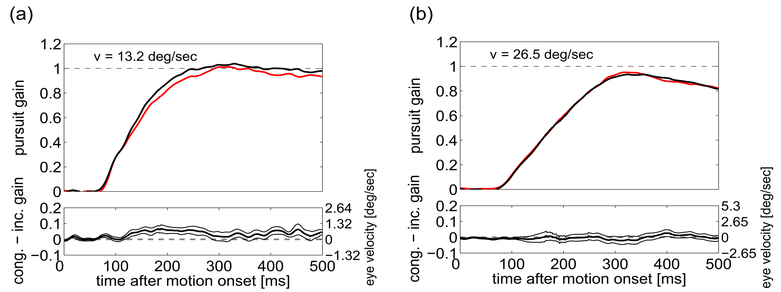
The task was to track the horizontal motion of a red dot surrounded by a rotating cloud of dots (b-d):

(a) Stimulus rotation was either **congruent** with an object (i.e. a stone) that is rolling on the ground without slipping or **incongruent**.



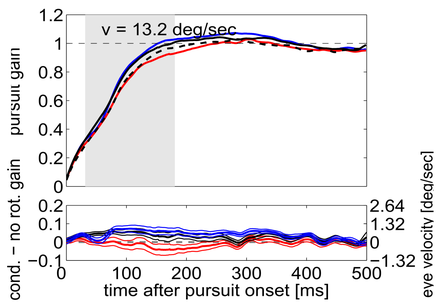
Results

❑ Exp1: Pursuit gain (eye vel./ target vel.) is higher with **congruent** stimuli compared to **incongruent** (a), but not with the high target speed (b)

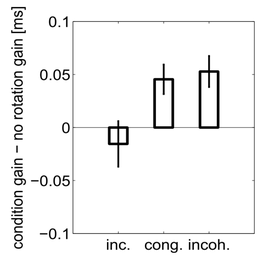


❑ Exp 2-3: Same congruence effects with interleaved and blocked presentations (low speed)

❑ Exp 4: Costs or benefits? **Congruent**, **incongruent** and **incoherent** motion was compared to **no rotation (---)** Only half the dots were congruent in the **incoherent** stimulus.



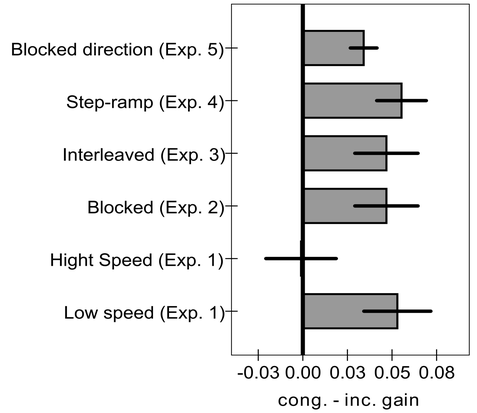
Benefits of congruence; little costs of incongruence



❑ Exp 5: No congruence effect on anticipatory pursuit (blocked direction), but on visually-driven eye movements

Summary Figure

Gain difference (congruent – incongruent) : 120-280 ms post onset



❑ Robust effect of congruence effect during pursuit initiation

❑ It doesn’t matter whether presentation is interleaved or blocked or whether we use a step-ramp paradigm.

❑ Exception: High speed (26.5 deg/sec). Saturation?

Conclusions

❑ Tracking eye movements are influenced by how ‘naturally’ a stimulus appears to move. Tracking errors are reduced with stimuli that have naturalistic kinematics as opposed to stimuli whose kinematics are less likely to be seen in the real world.

How?

❑ Internalized Newtonian physics [1]. Precise kinematics relevant.

❑ Learned association between rotation in a given direction and translation. Precise kinematics irrelevant.

References

1. McIntyre J., Zago M., Berthoz A., Lacquaniti F. 2001
Does the brain model Newton's laws? *Nat Neurosci 4(7), 693-694.*

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