ME 586: **Biology-inspired robotics**

Lecture 2

Prof. Sawyer B. Fuller

Goals:

- give advice for how to read a scientific paper
- introduce this year's term project
- Example paper presentation and discussion lead paper 0: McLeod & Dienes, "Do fielders know where to catch the ball or only how to get there"

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Note

- please give me paper preferences sheet by the end of class today.

how to read a paper

1. read the abstract - 2-5 min
2. look through the figures - 5-10 min
3. read the introduction - 5-20 min
4. read the conclusion - 10 min
5. read the rest of the paper - 1-10 hrs (depending on difficulty and detail desired)

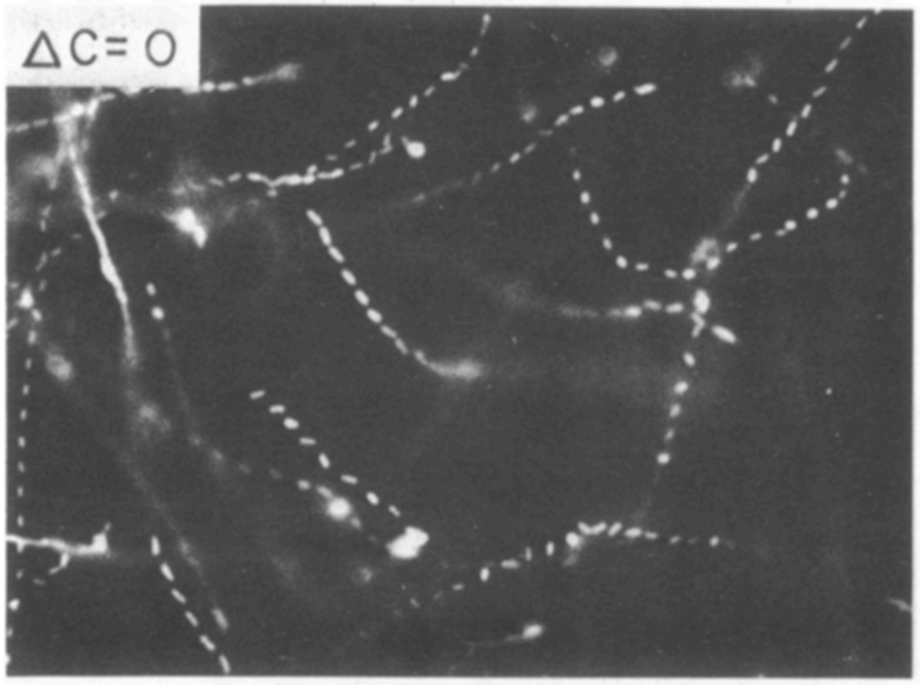
This year’s term project

- You’re the funding agency!
- each team submits a *research proposal* at the end of the quarter
  - format: 1-2 pages per student team member, NDSEG graduate fellowship format
  - includes preliminary work you did in this course
    - show a “proof-of-concept” initial work in some aspect of biology-inspired robotics (probably in simulation)
  - can be used to for your actual application
- There will be a ***peer review*** of proposals
  - criteria: quality of preliminary results, future promise
- top 3 proposals get funding — free coffee to start the research!

Paper 1 preview

- MacNab and Koshland, “The Gradient-Sensing Mechanism in Bacterial Chemotaxis”

- chemotaxis = moving toward a chemical source



- paper 1b: skim chapters 1-5 of Braitenburg1984

paper 0 presentation & discussion

Do fielders know where to go to catch the ball or only how to get there

Peter McLeod & Zoltan Dienes
Journal of Experimental Psychology, 1996

Presented by Sawyer Fuller

does this fielder know where ball will land?

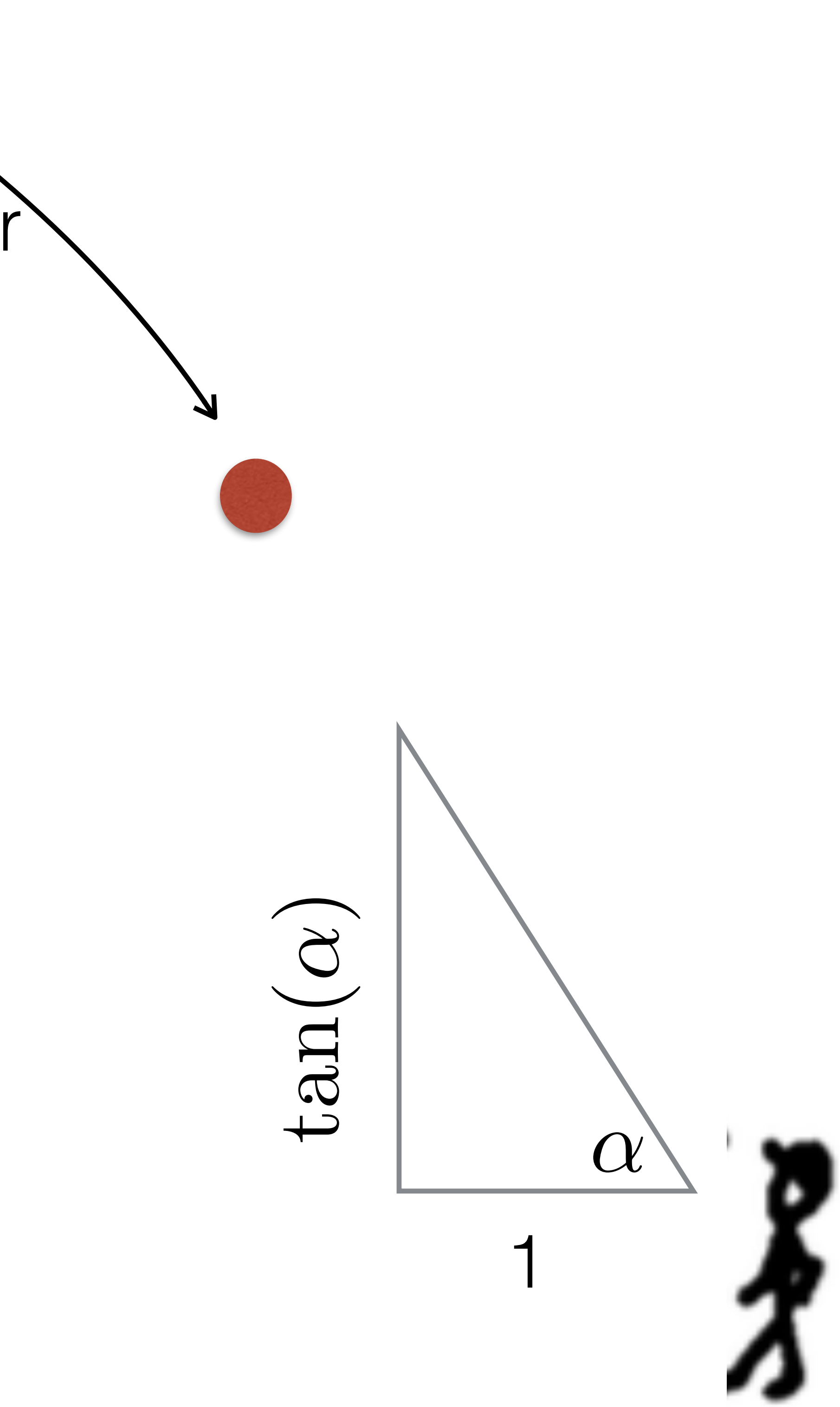
previous work

- Chapman (1968) observed that if a fielder runs at a constant speed such that

$$\frac{d}{dt}\tan(\alpha) = const$$

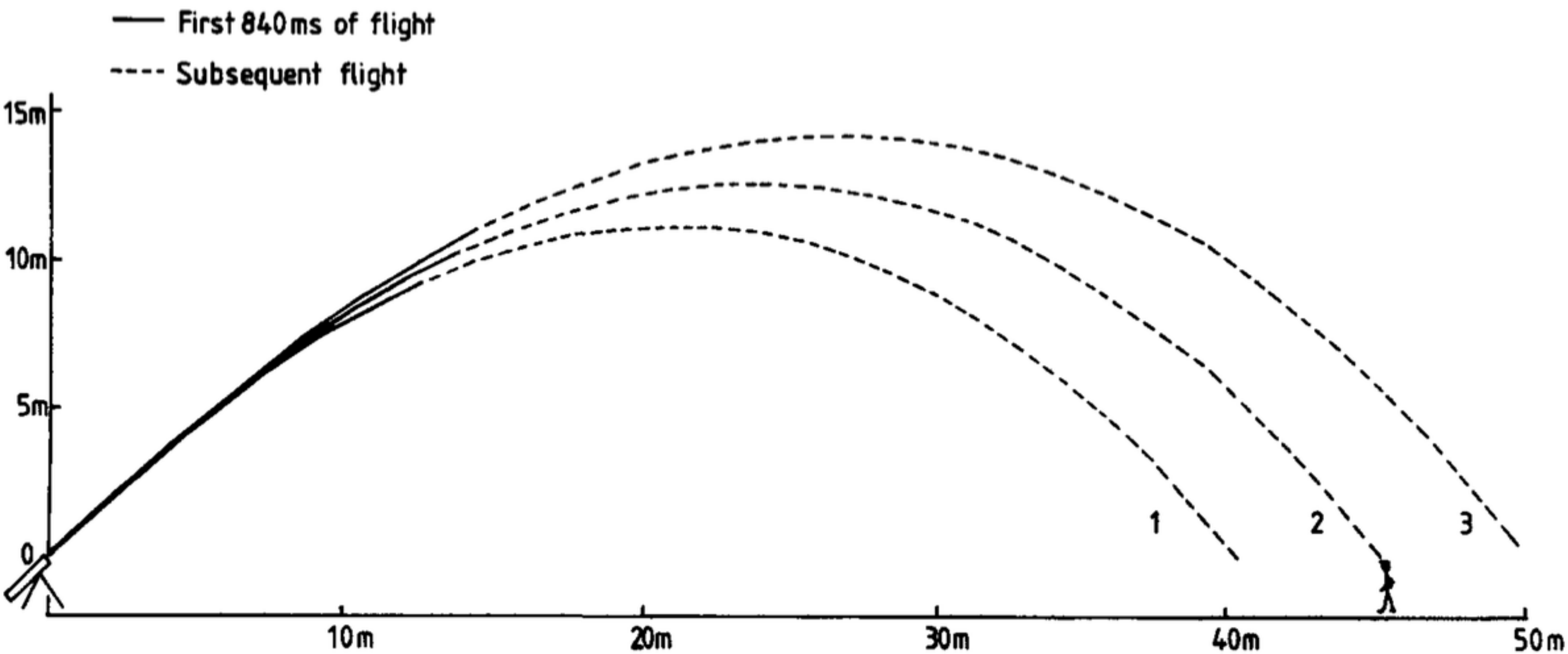
she will intercept a parabolic trajectory

- problems:
    - because of air drag, path of ball is far from parabolic
    - does not specify how to choose the "constant running speed"



this paper: can we better understand the underlying mechanism?

- Experimental setup: fielder catching fly balls
- focus on front-to-back motion, not side-to-side



Experimental setup

- camera tracks fielder

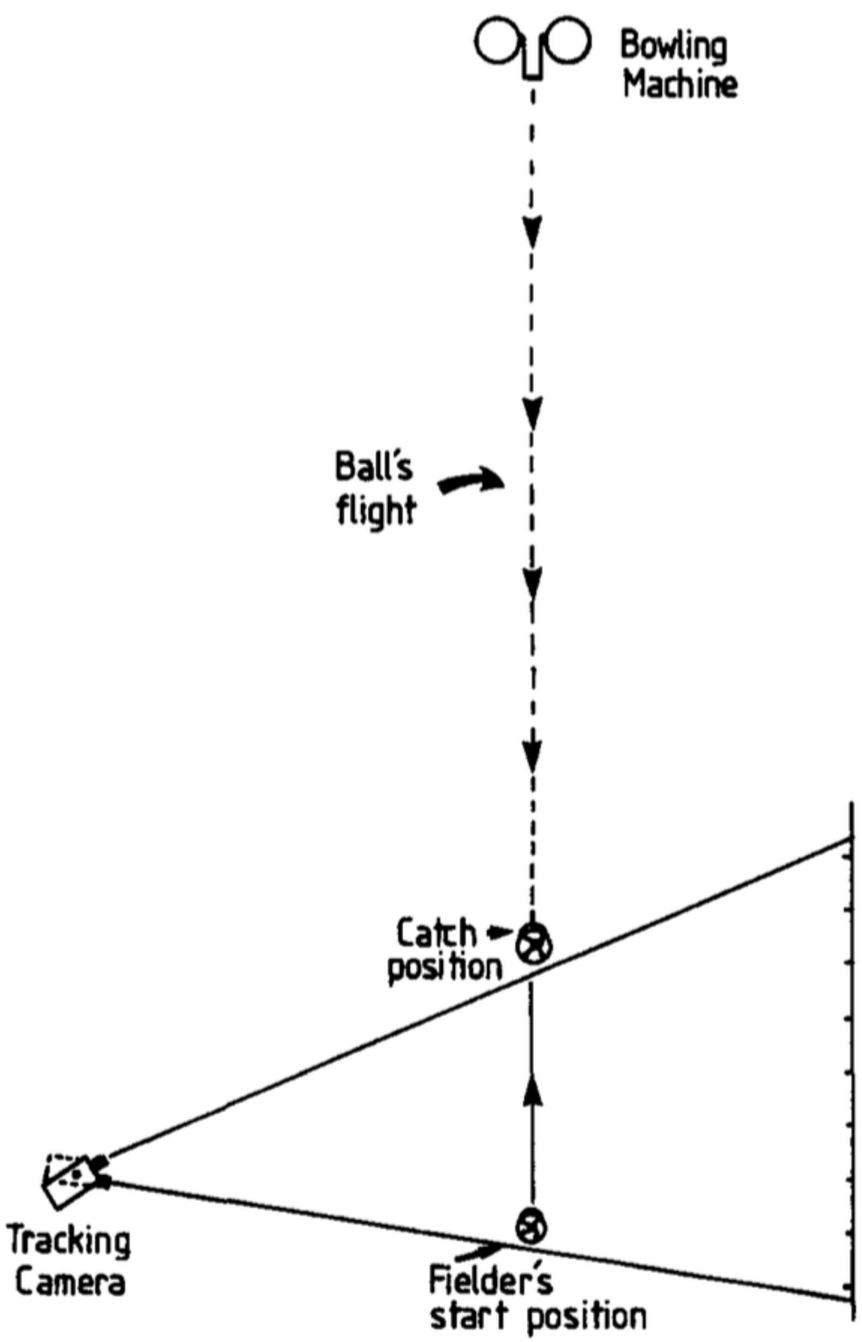


Figure 2. The experimental setup as viewed from above. A

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experiment 1: 45deg at different speeds

- variable running speed, but dtanα/dt ~ const

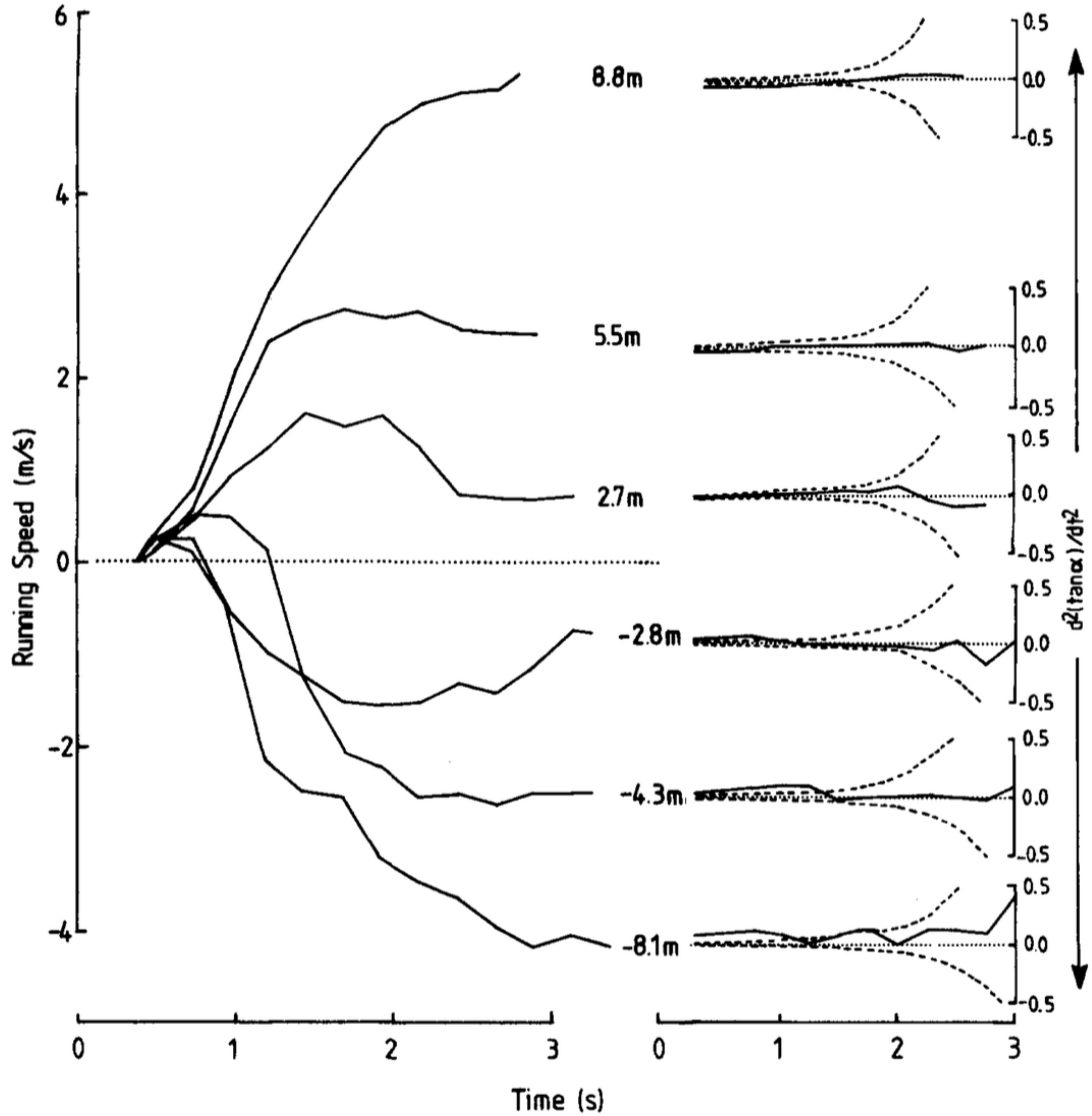
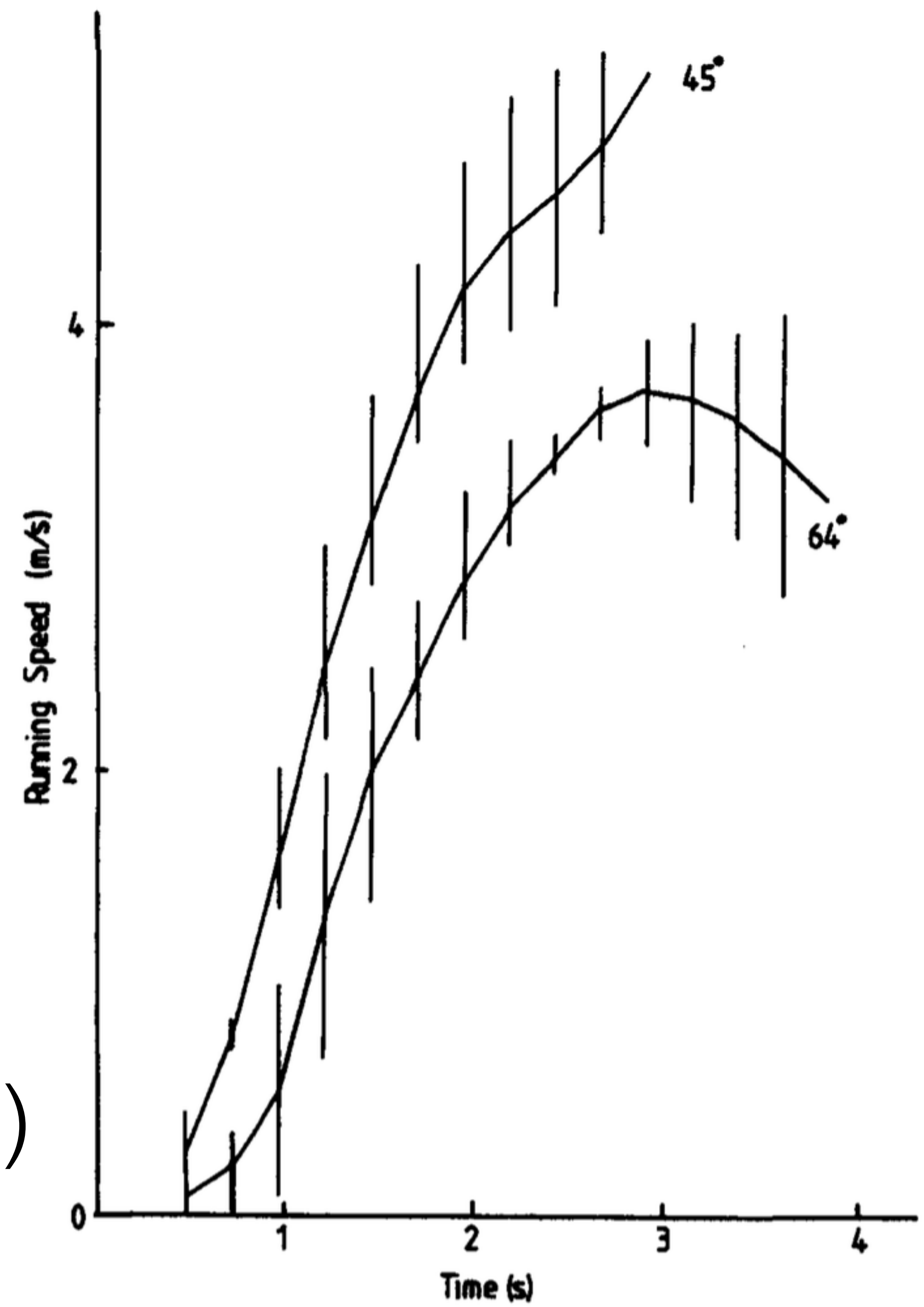


Figure 3. The left panel shows the fielder's running speed as

experiment 2: 45 and 64 deg

- runner runs slower if ball takes longer, rather than running full speed and arriving early



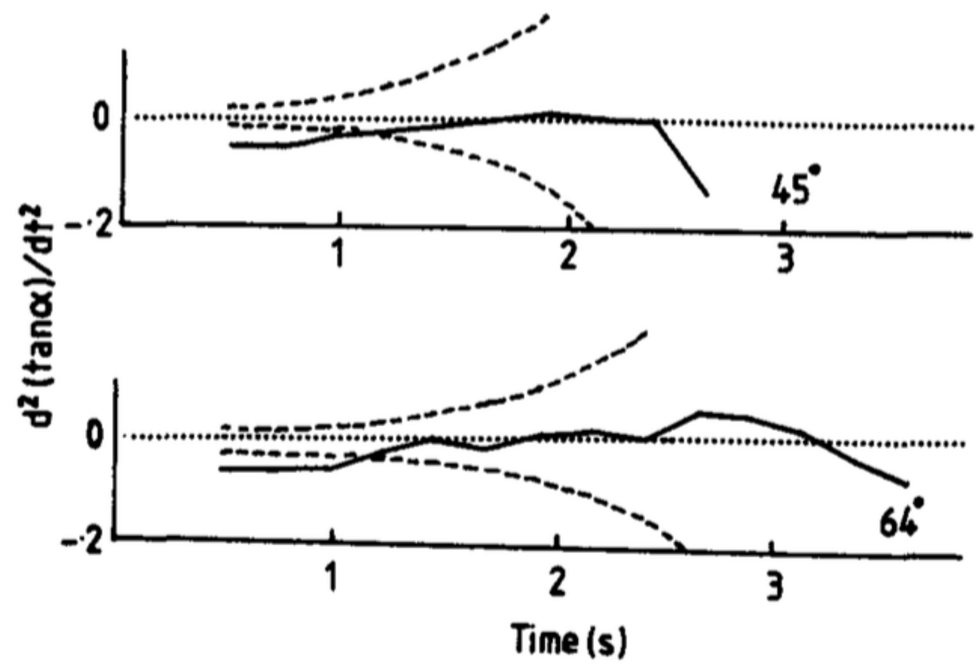


Figure 4. The fielder ran to catch balls landing 8–10 m in front

(figure 4)

missing the ball

- running too slowly so that $d^2\tan\alpha/dt^2$ never goes to zero

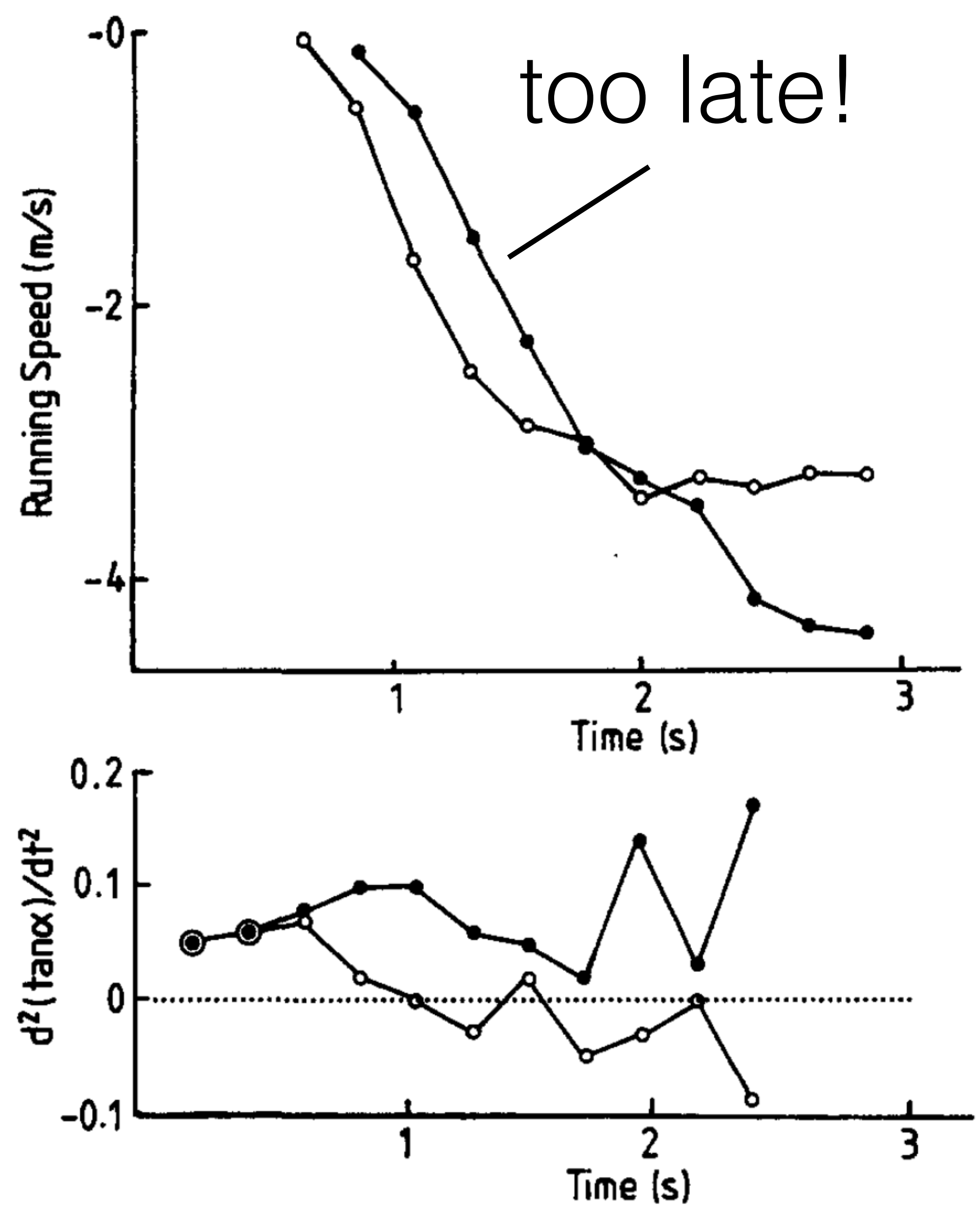


Figure 5. Velocity and $d^2(\tan\alpha)/dt^2$, as in Figure 3, for two

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alternative hypotheses

- rejected: keeping alpha constant

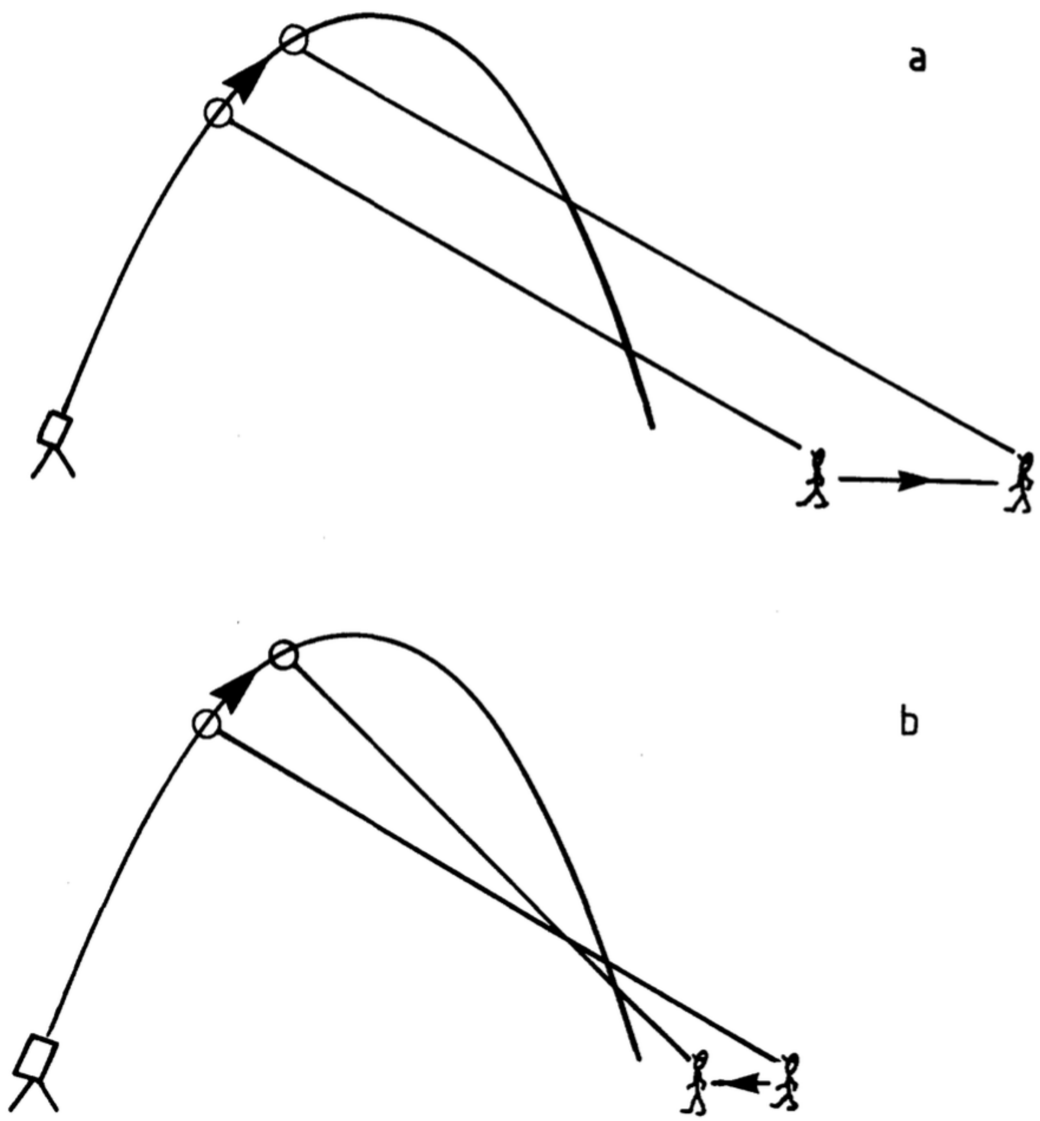

Figure 8. Two strategies for interception when the fielder should run forward. (a) Keeping the

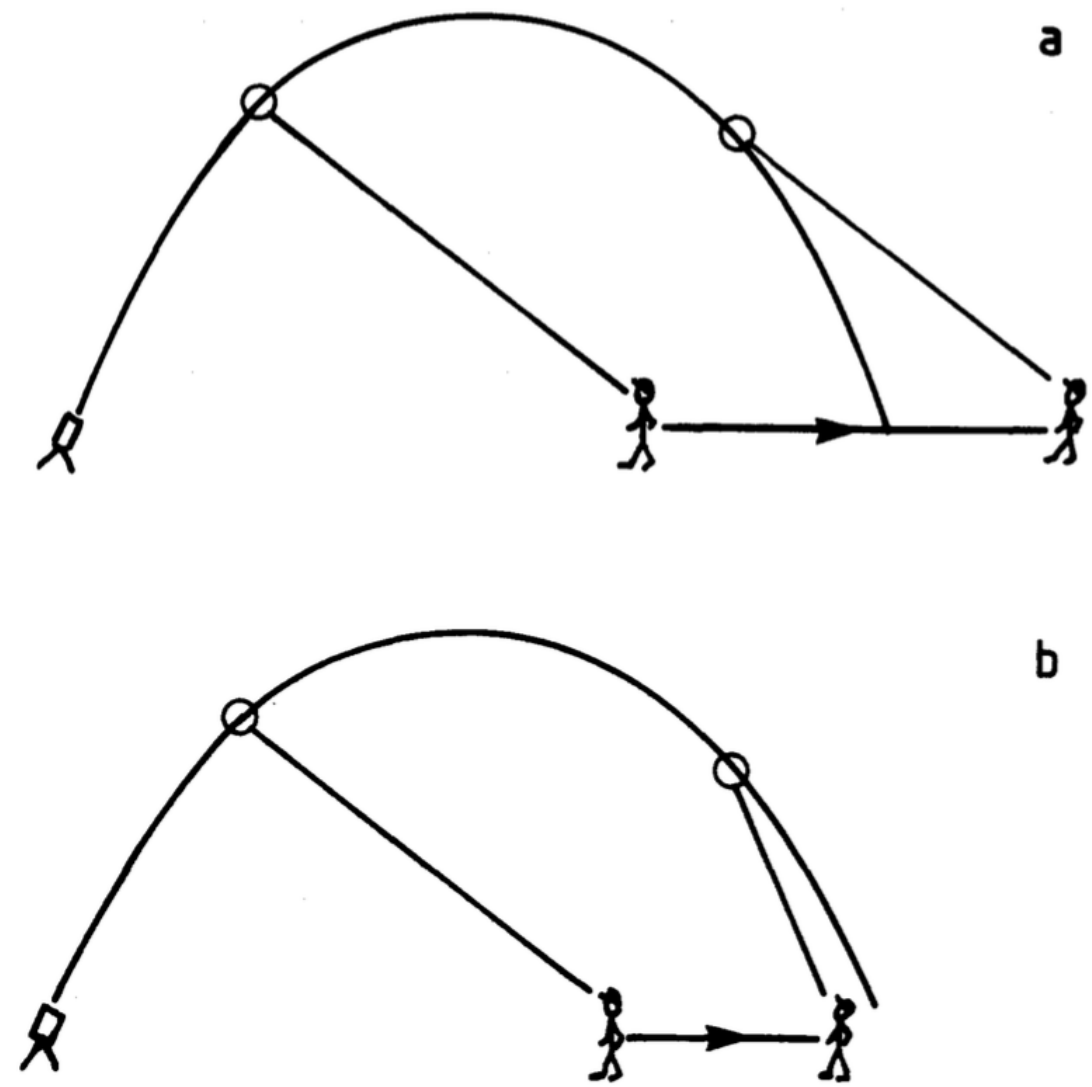

Figure 9. Two strategies for interception when the fielder is running backward. (a) Keeping the

alternative hypotheses

- rejected: d2α/dt2 = 0 (lines not straight)

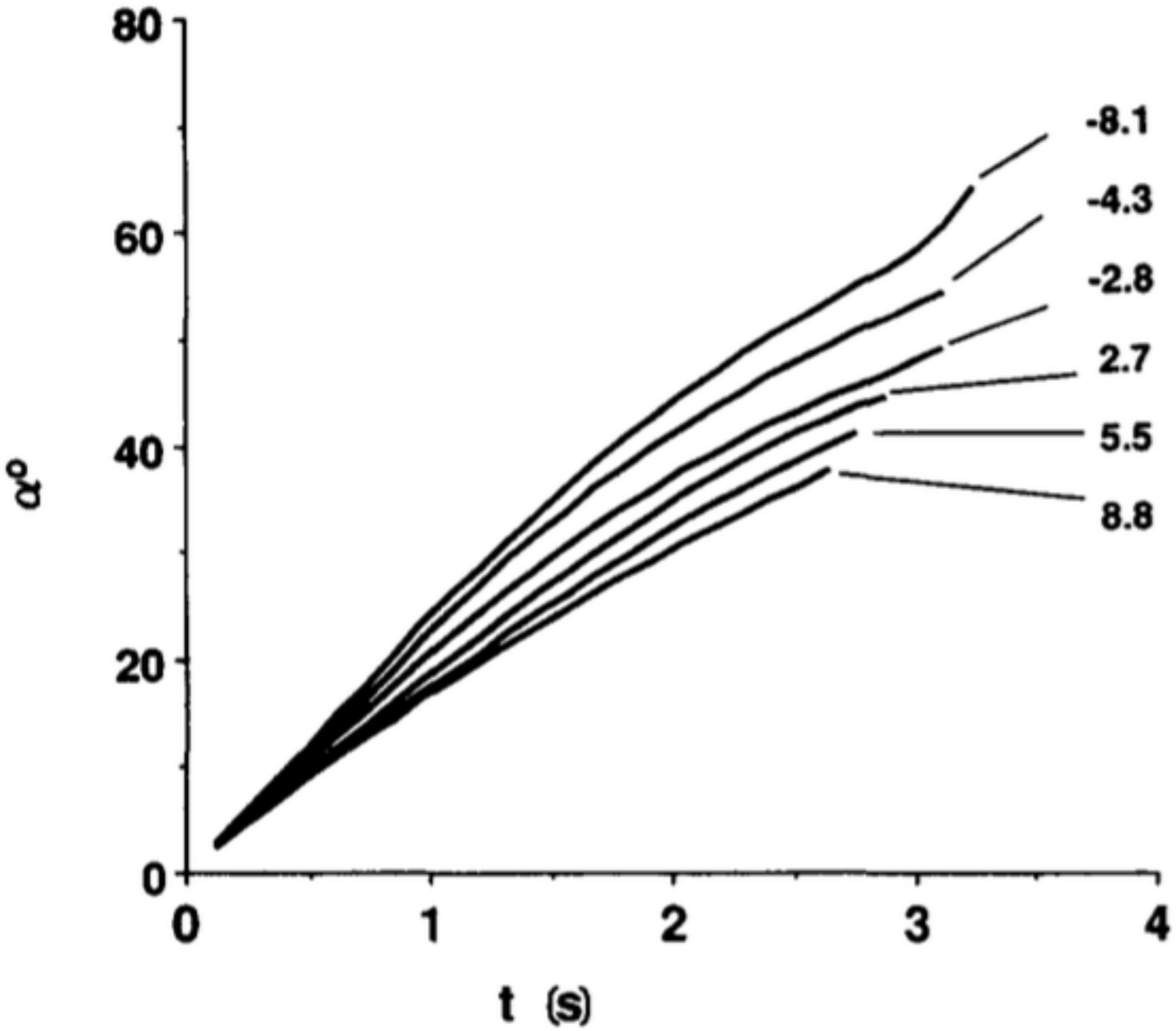

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Figure 10. Angle of gaze as a function of time for the six

Their conclusion:

runner implements a *feedback* controller ("servo"):

$dv/dt = K\, d^2\tan\alpha/dt^2$

summary

- fielders are not running at constant speed to ball
- consistently, they are running at the moment they intercept it
- they didn’t use spare time to run to where the ball would fall
    - this suggests they don’t know where that will be
- dynamic behavior suggests a simple *feedback law*

Reminder for when you are presenting a paper

- In addition to presenting, you will also lead the discussion of the paper
- don’t write a review
- Instead, make a blank post so you can read other reviews. Then, skim through the reviews and come prepared to bring up their questions and comments

discussion comments

- calculating a second derivative is noisy
- “good players often stop and wait for the ball to land”
- what about lateral motion?
- great thing to test with a simulation!
- next question: how is this learned?