Biomechanics in Football

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Football Injuries

Motivation

- Media and Public Perception
  - Is heading in soccer safe?
  - Are brain injuries a problem?
  - Concern about cumulative effects?
  - Is protection needed (headgear, mouth guards)?
  - Does headgear work?
  - Are children especially at risk?

Motivation

- Game Play Activities
  - Heading restricted for children
  - Reduced heading exposure in training
  - Protective equipment being mandated
  - Low mass/pressure balls for heading
  - Skill development

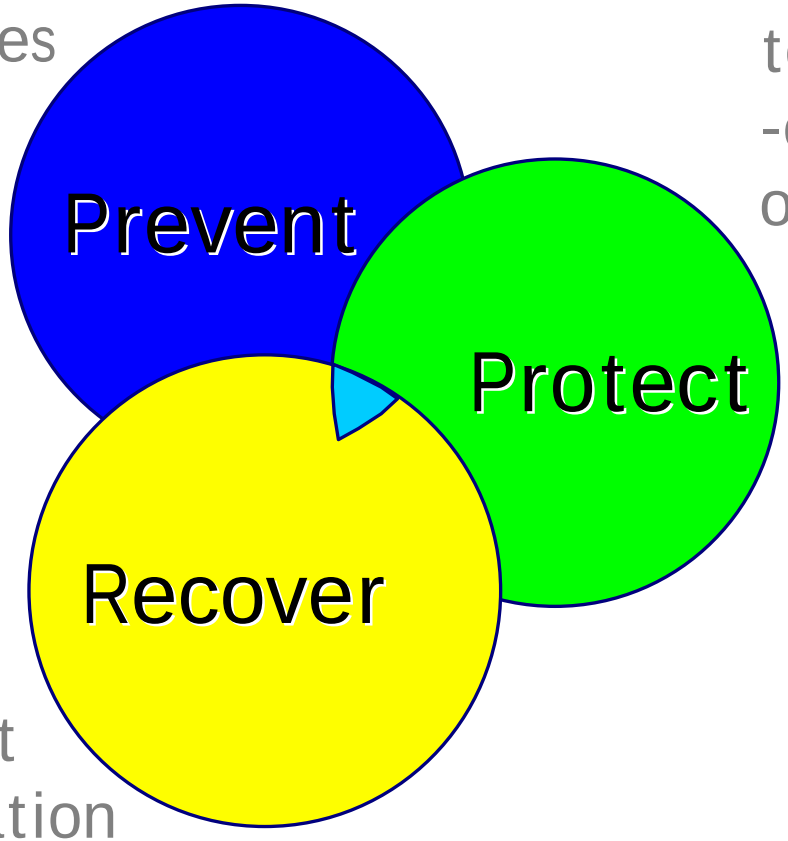
Motivation

- Medical/Scientific Community
  - early studies indicating potential safety issues
  - Neuropsychological, neurophysiological deficit
  - Concussions, long term effects
  - Impact tolerance
  - Incidence of injury
  - Research split about risks

Safety Approach

Eliminate Threat
-game play rules
-training guidelines

Reduce Severity and Occurrence
-strength, skills, technique
-equipment on/off player



Recover
-diagnosis
-treatment
-rehabilitation

OBJECTIVES

Study Objectives

- Identify methods of head impact reduction through biomechanical studies:
  - heading techniques
  - ball properties
  - head impact
  - headgear

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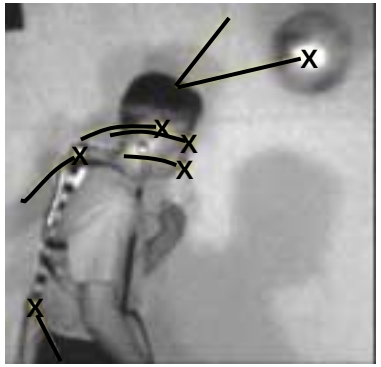
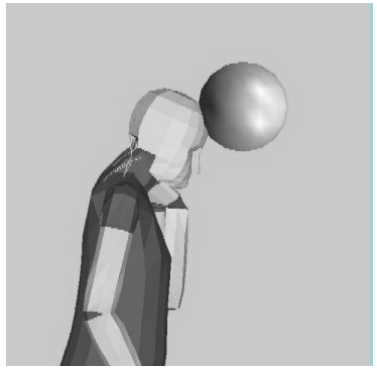
HEADING

Methods - approach

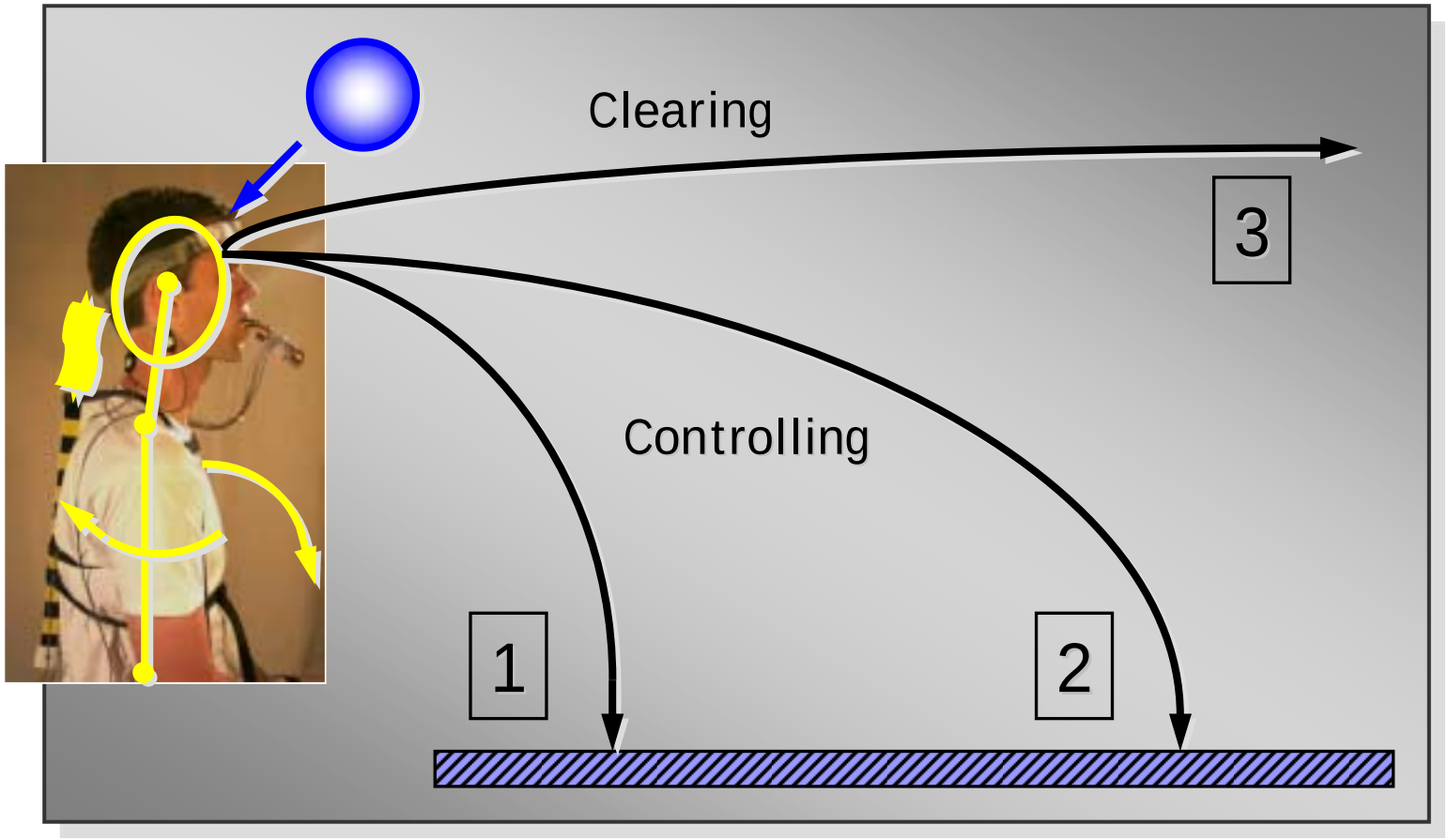
Investigation



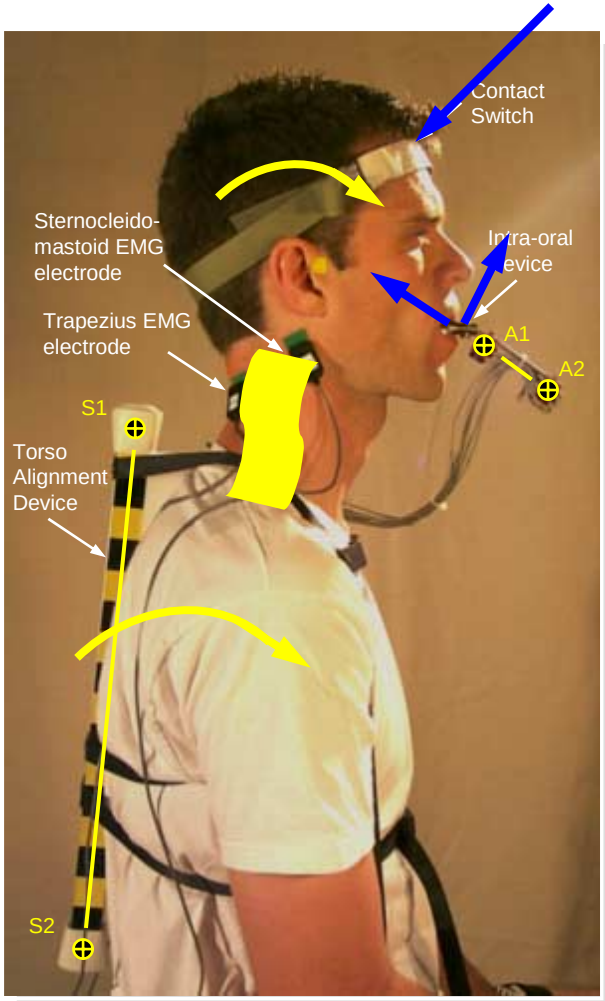


Confirmation

Methods - conditions



Methods - instrumentation



Subject Measures

Head Responses:

- linear acceleration
- angular acceleration
- head impact power

Motion Analysis

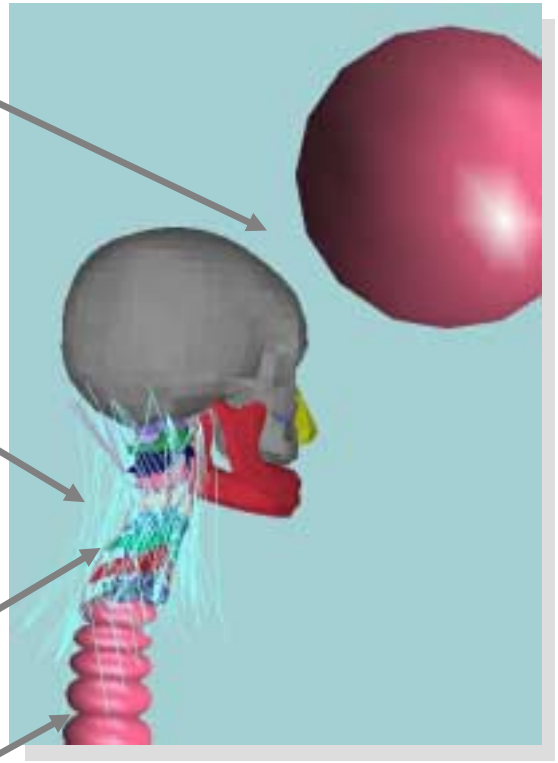
Methods – model

Ball-Head Contact Model

Neck Muscle Groupings

0C-C7 Vertebrae

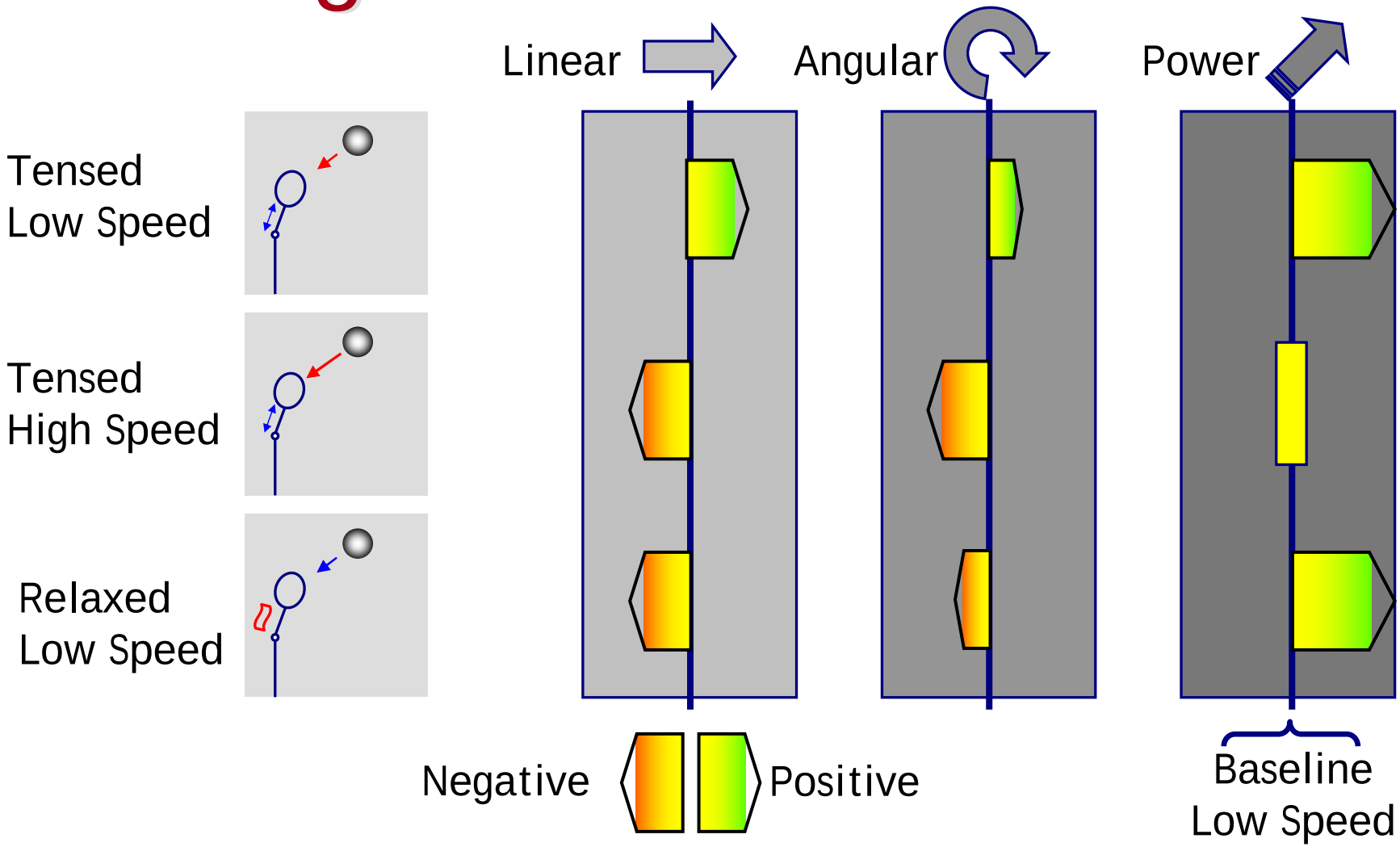
Coupled Torso



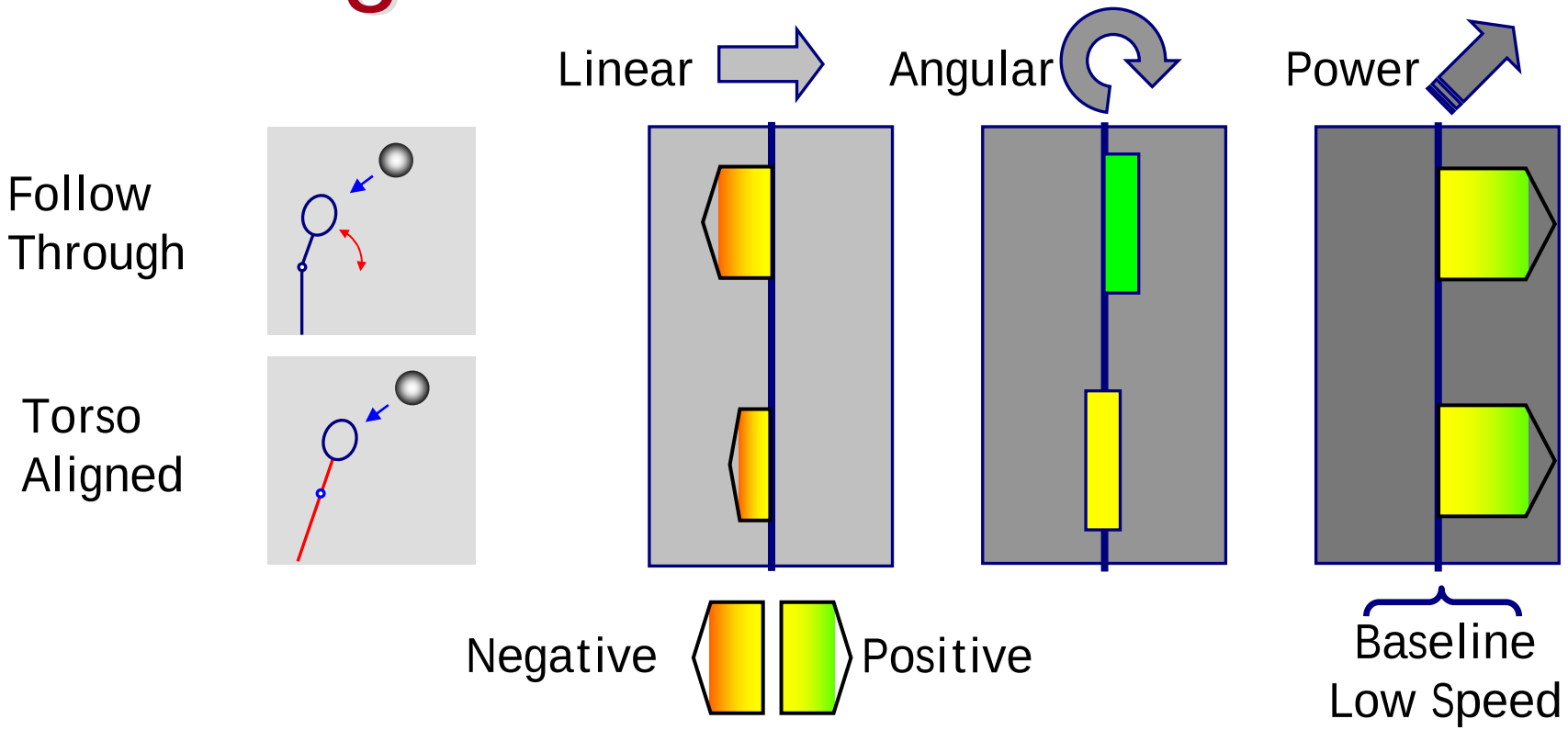
Model Structure

Model Dynamics

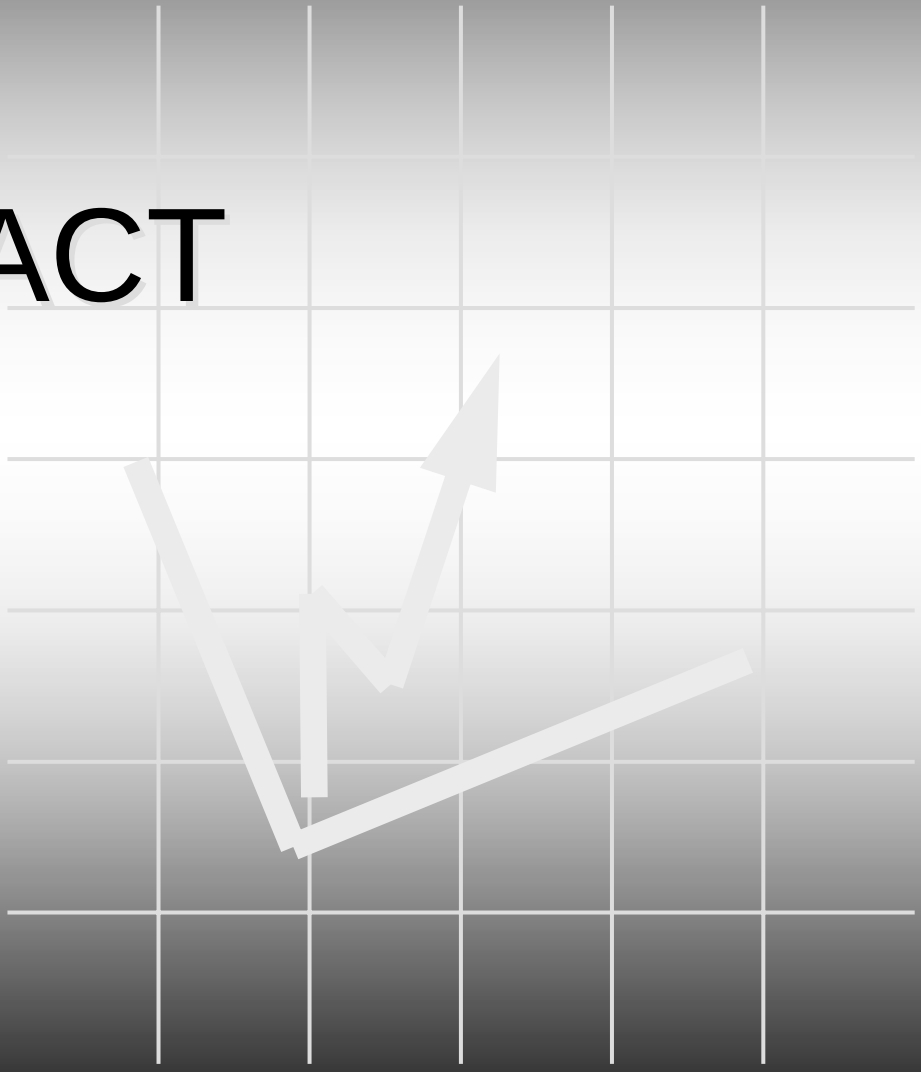
Findings – neck muscle effects



Findings – torso effects



HEAD IMPACT



Head Impact

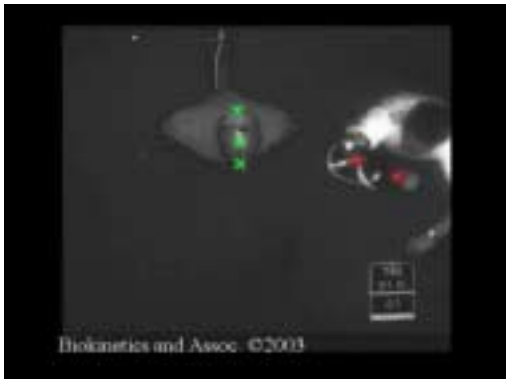
- Impacts = low to life threatening
- Caused by:
  - upper extremity
  - head to head
  - head to lower extremity
  - head to goal post
- Accidental & intentional
- Avenues for reduction/prevention

Methods – head impact

Investigation - elbow to head

Identify Conditions

Assess Impact Severity



Kinematic Analysis

Biomechanics

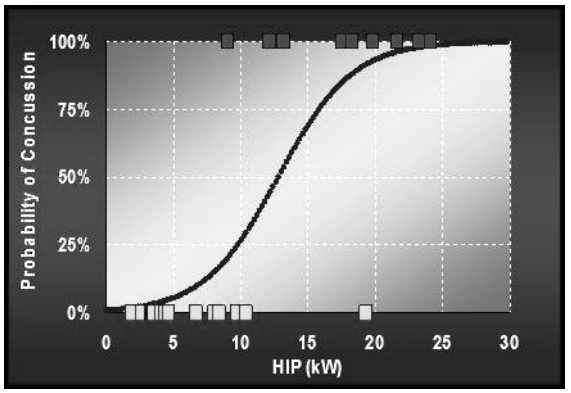
- Wrist to head impacts also investigated

Methods – head impact

Investigation - Head to head

Identify Conditions

Assess Impact Severity



Biomechanical Analysis

Findings - head impact

- Impact conditions established from video
- Head and neck impact response measured
- Upper ext. impacts = clinical importance
- Head-to-head impacts = greater severity
- Accidental impacts = random, controllable?
- Intentional impacts = systematic,
  can be controlled

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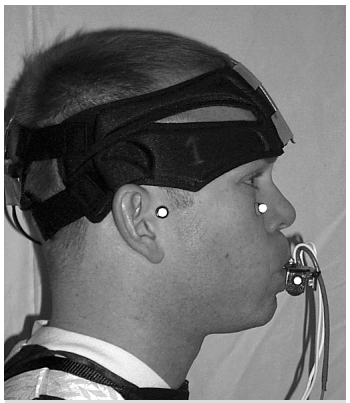
HEADGEAR

Methods – head gear

Ball Contact

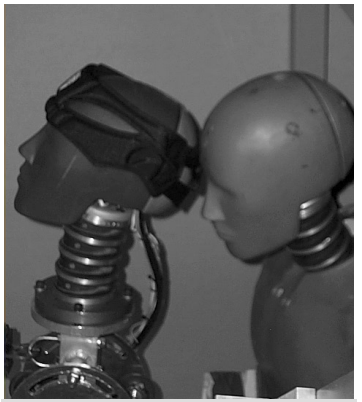


Low Severity

High Severity

Head-to-Head

Temple Impact



Occiput Impact

Findings - headgear

- Headgear = no benefit for intentional or accidental ball impact (6-30 m/s)
- Headgear = benefit (6%-69%) for head-to-head contact (2-5 m/s)
- Certain models of headgear provide little protection above 3 m/s.

BALL PROPERTIES

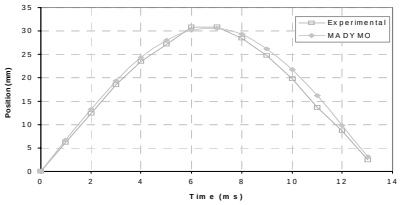
Ball Properties

- Ball properties (mass, pressure, speed, others) responsible for level of impact
- Some organizations recommending lighter or low mass balls for training

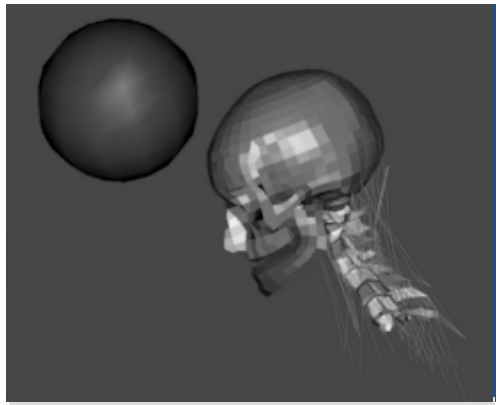
Methods – ball properties

Investigation - Head to head

Human Subjects



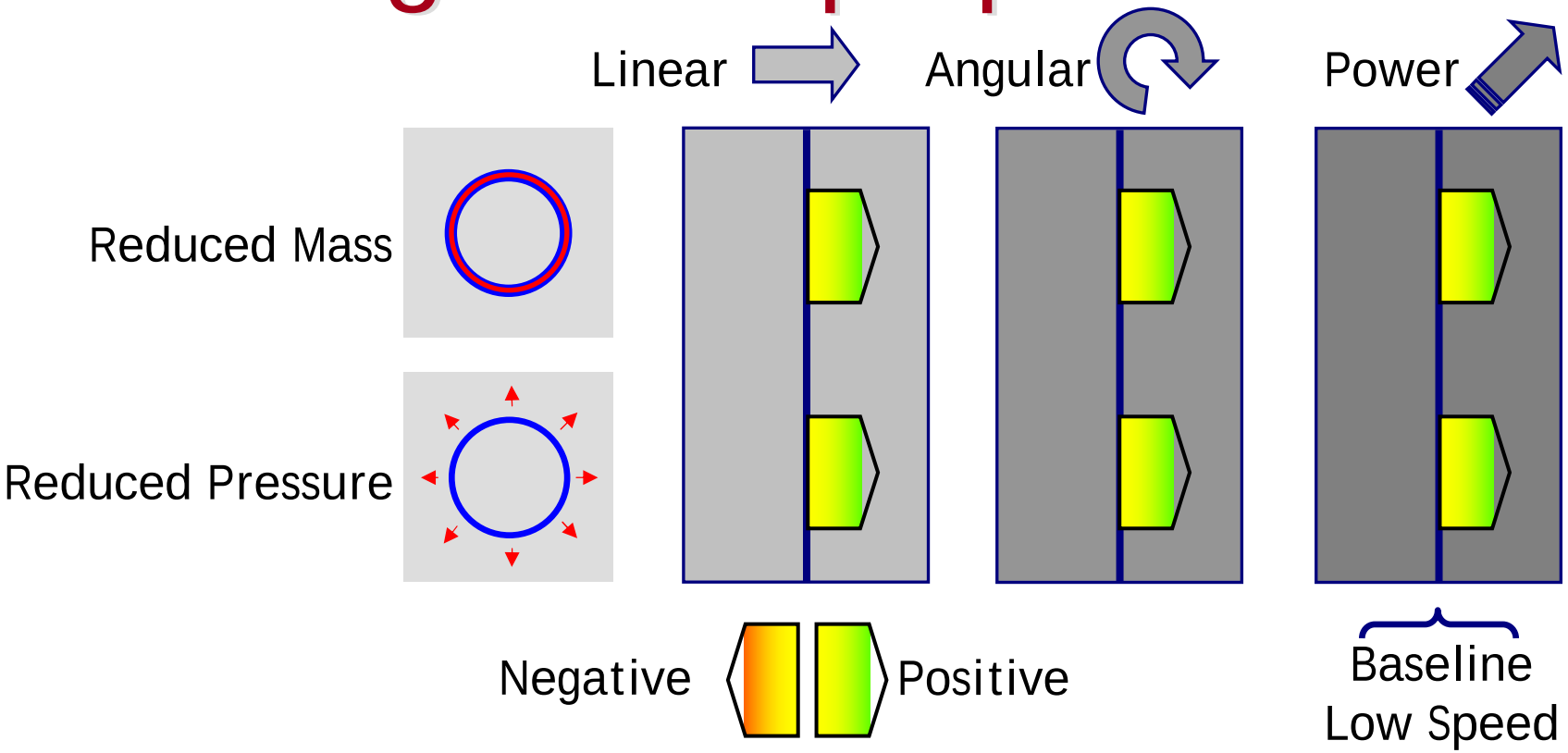
Ball Response



Verification

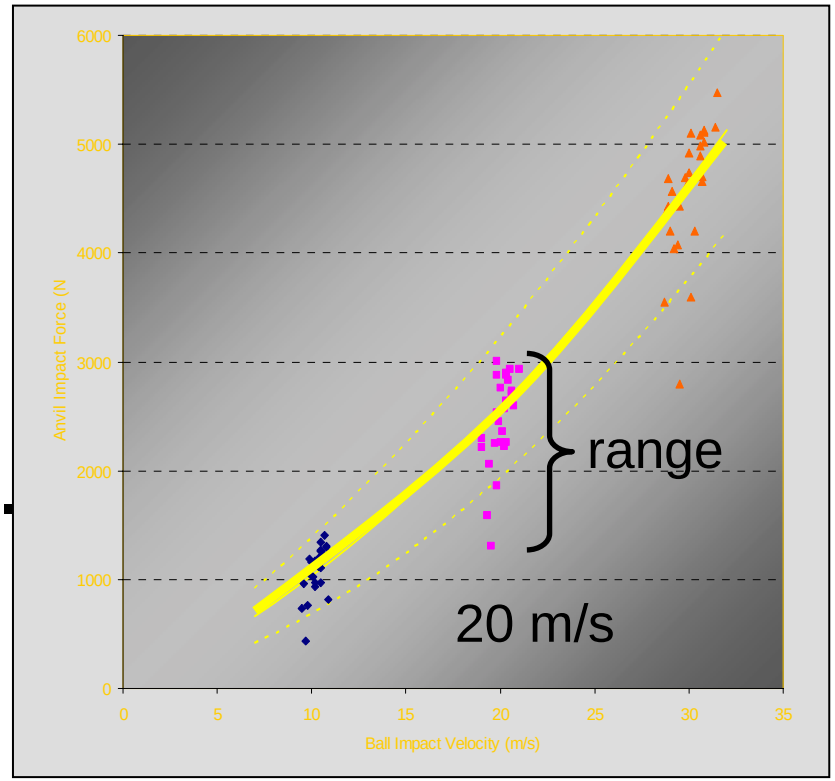
Confirmation

Findings – ball properties



Methods - ball properties

- Ball speed varies with player age, skill level, and game type
  - kicked 17-33 m/s
  - headed 1-14 m/s
  - research 6.3-12 m/s
- Ball response vs. properties (mass, press. stiffness, impulse, disp. force, power)



SUMMARY

Summary

Impact Reduction Approaches

Impact Contributors	Skills and Regulating	Ball Properties	Headgear
Heading	?	✓	X
Head to Head	?		✓
Head to Extremity	✓		?

Recent Advances - football

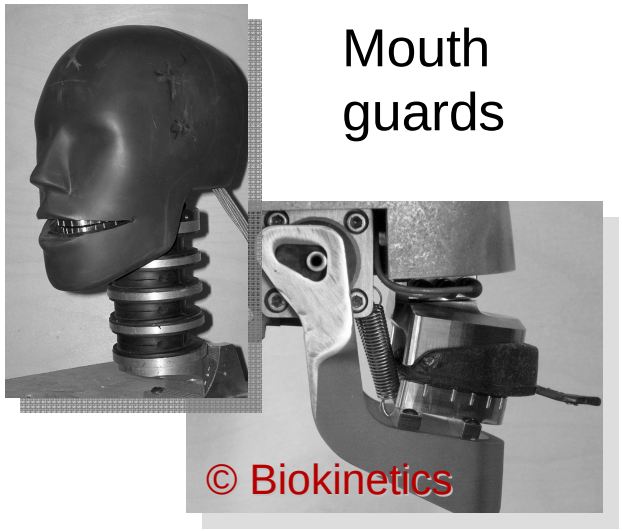
- Research published in BJSM (Vol. 39, S1)
- Prospective injury studies
  - type, incidence, mechanisms, biomechanics
- Player training and skills development
- Game play environment changes
  - footballs, artificial turf, rules

Recent Advances - sports

- Prospective studies to evaluate protective gear (football, rugby, American football)
- Performance standards being developed
- Positive changes

Helmets for MTBI

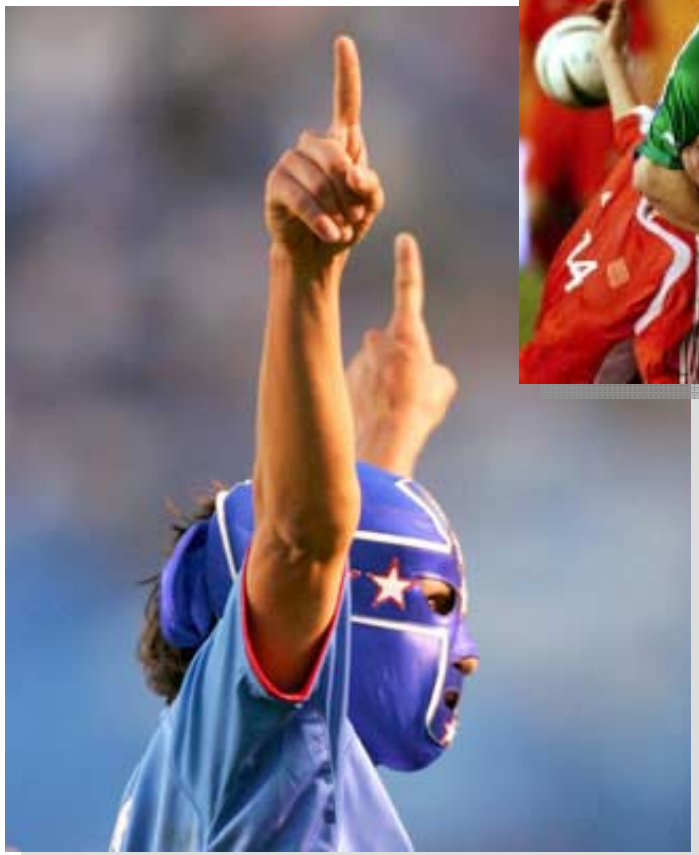
Mouth guards



Acknowledgements

- FIFA Medical Assessment and Research Centre
- FIFA Marketing & TV

Future Challenges?



Questions?