Intercepting a 3D versus 2D videoed opponent:
Visual search and reaction time differences

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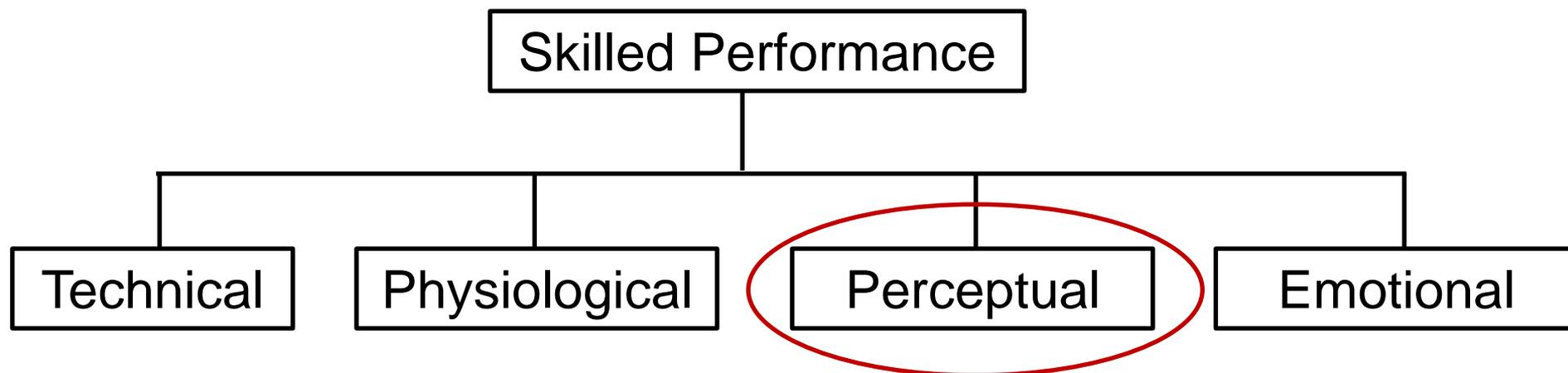
How to become an expert?

Rationale:

- Study expert-novice differences
- Identify expert advantage
- Train novice to improve

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                    ┌─────────────────────┐
                    │ Skilled Performance │
                    └─────────────────────┘
                               │
        ┌──────────────┬───────┴───────┬──────────────┐
   ┌──────────┐  ┌──────────────┐  ┌────────────┐  ┌───────────┐
   │Technical │  │Physiological │  │ Perceptual │  │ Emotional │
   └──────────┘  └──────────────┘  └────────────┘  └───────────┘
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Perception

" There is increasing awareness that skilled perception precedes and determines appropriate action in sport."

Perceptual expertise
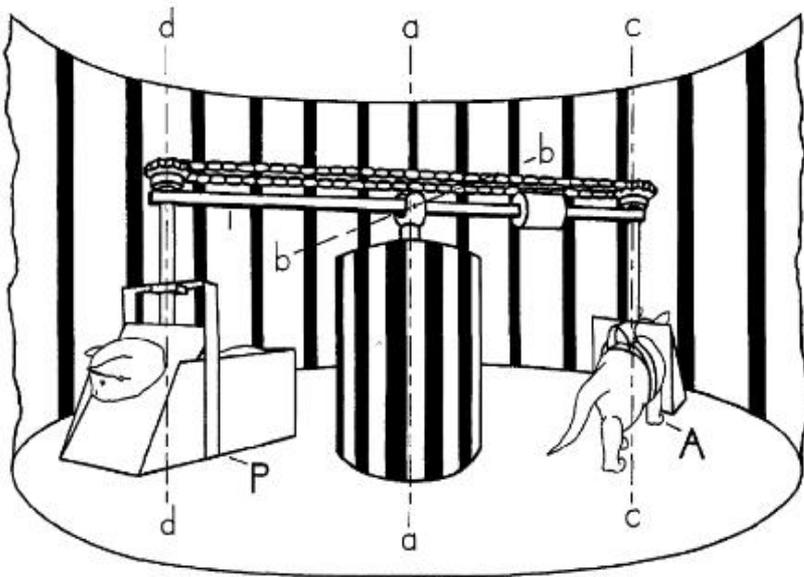
Experts demonstrate superior:

- pattern recognition & recall (Williams & Davids, 1995)

- detection/recognition of objects (Millsgale, 1988)

- visual search of anticipatory visual cues
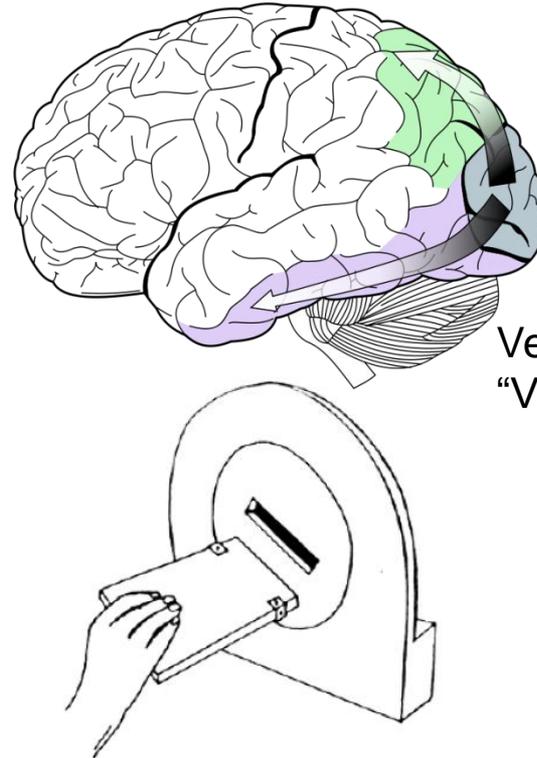 (Williams and Burwitz, 1993; Williams & Davids, 1998)
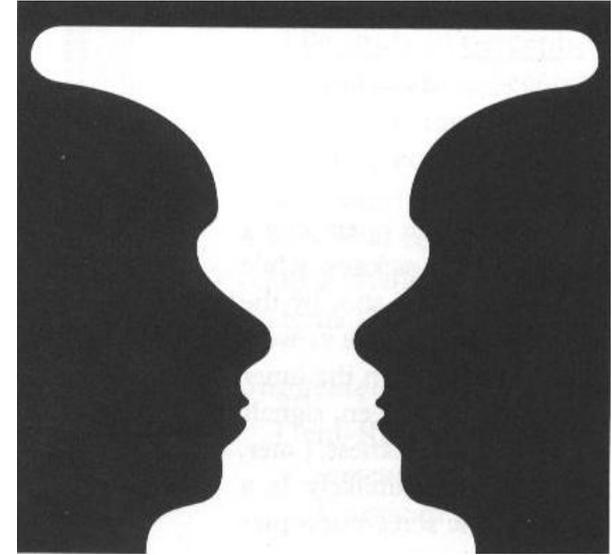
Only when visual stimuli is sport-specific & realistic

Enhanced perception = Expert performer?

Action also drives perception … …

Held & Hein (1963)

Dorsal stream:
"Vision for action"

Ventral stream:
"Vision for perception"

Milner & Goodale (1995)

Skilled action = Perception + Action Van Der Kamp et al., (2008)

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Skilled evasion

Skill breakdown

Successful Evasion/Skilled Action =
Perception + Action

Preparatory action:
Looking for pass

ing right

Theories of acquiring/performing perceptual-motor skill
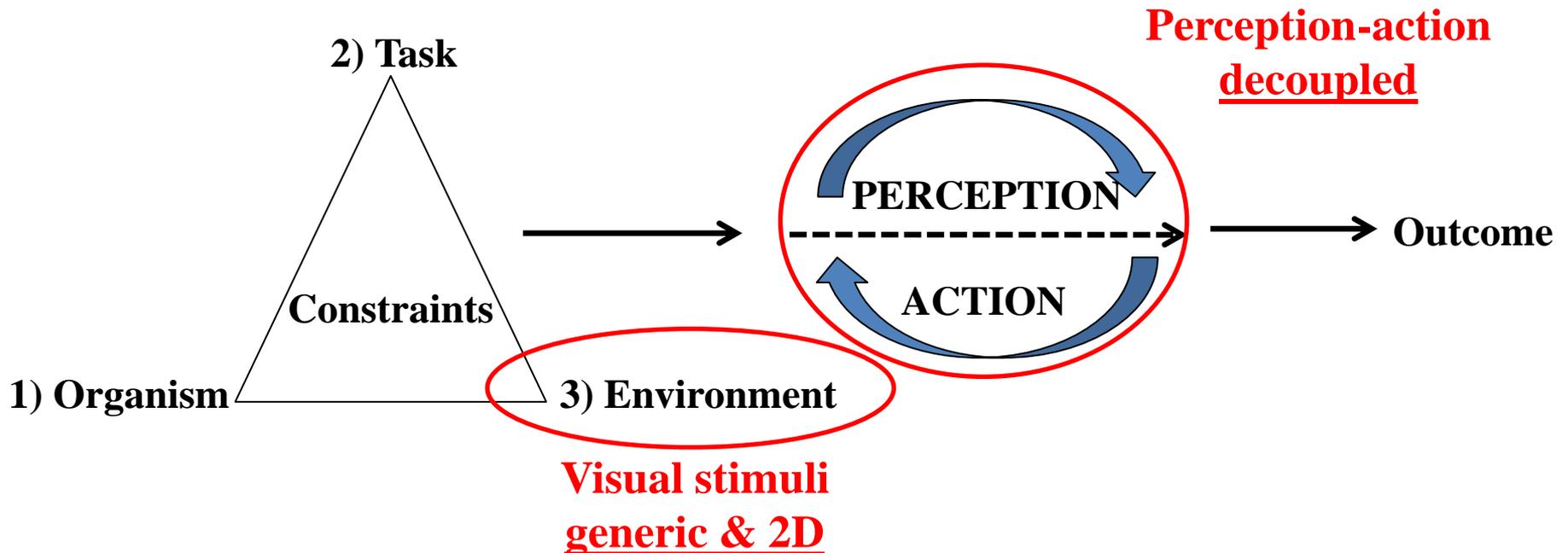
Cognitive Psychology
(Sternberg, 1969)

Dynamical Systems
(Kelso, 1984)

Ecological Psychology
(Gibson, 1977)

Constraints-led Perspective
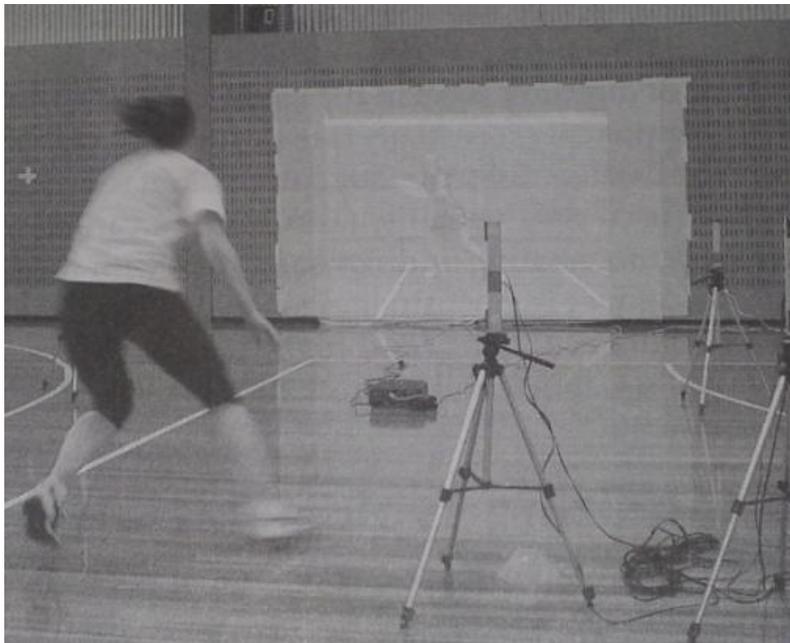(Newell & MacDonald, 1994)

Constraints-led perspective to assess/learn perceptual-motor skills

(Newell & McDonald, 1994)

2) Task

Constraints

1) Organism

3) Environment

Visual stimuli generic & 2D

PERCEPTION

ACTION

Perception-action decoupled

Outcome

Moving toward game-realism ... ...
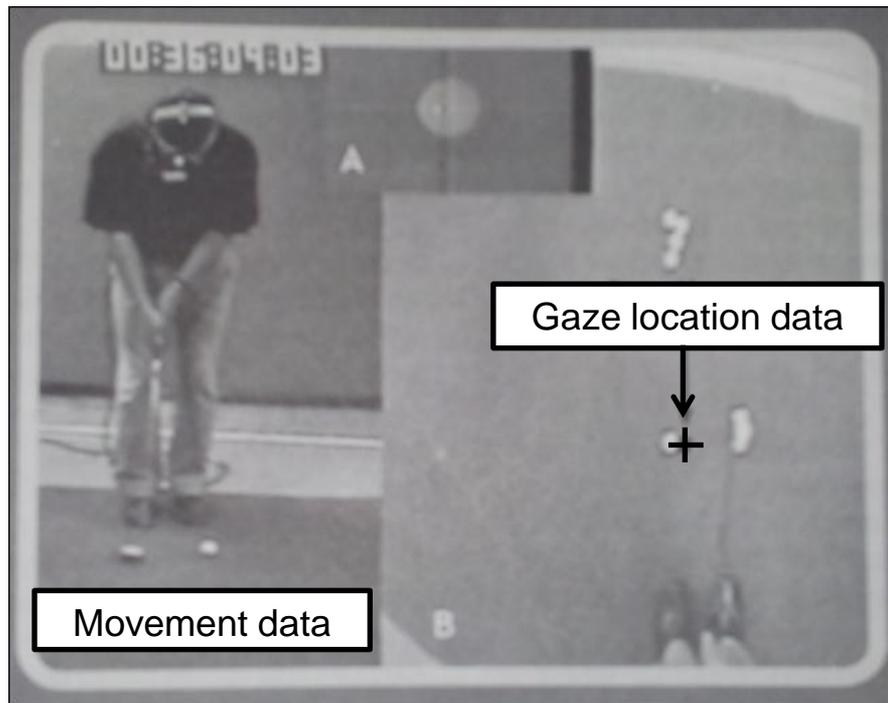
Reactive agility in netball (Farrow et al. 2005)

Importance of depth perception?

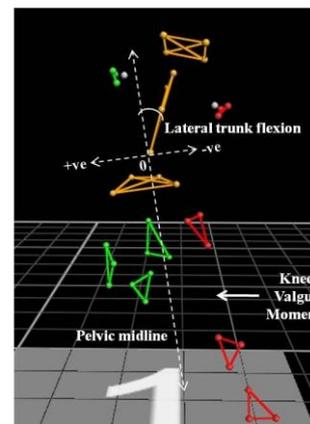# Moving toward assessing <u>coupled</u> perception-action ... ...

Vision-in-action paradigm
(Vickers, 2007)

Gaze location data

Movement data

Movement is 3D and could be fast … …

Lateral trunk flexion

+ve ← → -ve

0

Knee Valgus Moments

Pelvic midline
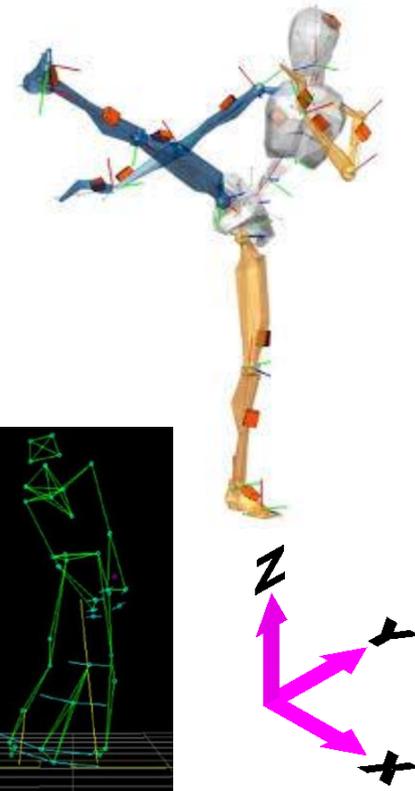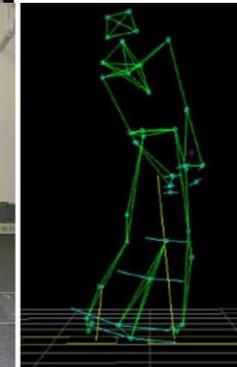
Aims

Technological:

- Introduce 3D quasi game-realistic visual stimuli into laboratory

- Integrate visual-perceptual and movement measurement systems

Experimental:

- Investigate differences in perception and action when responding to the same visual stimuli in 2D and 3D

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Development of Integrated Stereoscopic System

- Stereoscopic system capable of recreating visual field of athlete. (Lee

Stimulus footage
Gaze-Mobile Eye footage-emen
creation

Stereoscopic system

Or

Mobile Eye

Mobile Eye

Infra-red (IR) trigger gates

3D IR motion capture

Modified

Electromyography (EMG) system

zed lenses

Stereoscopic system

USB interface unit

Intercepting a 3D versus 2D videoed opponent: Visual search and reaction time differences

Aim

Differences in perception action when intercepting a 3D opponent compared with 2D

| Independent variables	Dependent variables
3D vs 2D	Gaze behavior (perception): • no. of fixations • duration of fixations • time spent fixating on different locations
	Reaction time (action)

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Methods

Participants:
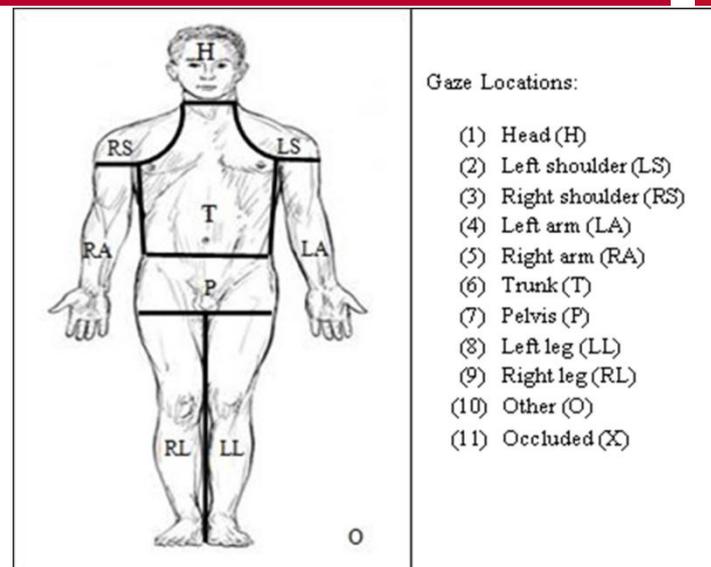
- 10 active males (22.1 ± 1.3 yrs)

Familiarisatio

Actual testing

Footage:
- Oncomin
- Running
- Change of direction eit**3. Interception**.6m from participant
2. Reorganisation
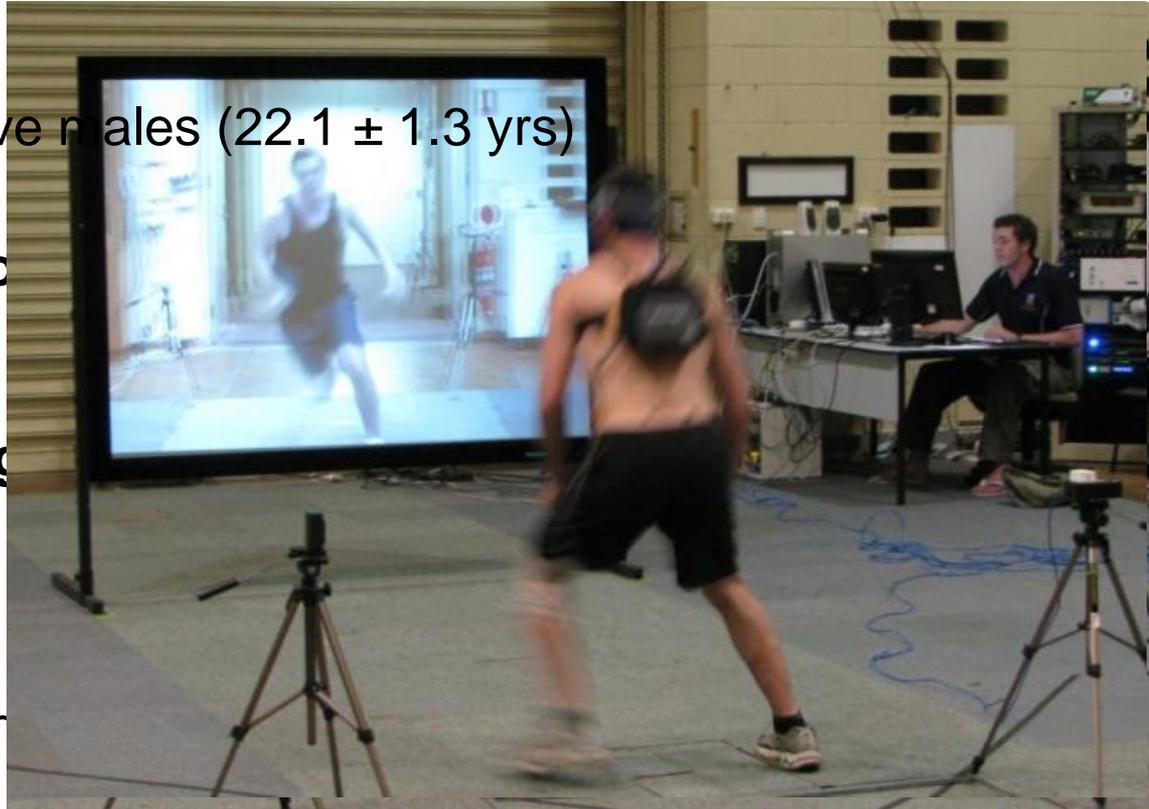
Data collection and analysis

Gaze behaviour:

- Total number and duration of fixations

- Total time spent fixating on different locations

Gaze Locations:

(1) Head (H)
(2) Left shoulder (LS)
(3) Right shoulder (RS)
(4) Left arm (LA)
(5) Right arm (RA)
(6) Trunk (T)
(7) Pelvis (P)
(8) Left leg (LL)
(9) Right leg (RL)
(10) Other (O)
(11) Occluded (X)

Reaction time:

- 1st lateral movement of opponent's push-off foot to lateral shift of participant's mid-pelvis

UWA Lower Body & Torso Model (Besier et al., 2003)

Results: Gaze behavior

Total number of fixations and fixation duration averaged across 12 trials and participants in the 2D and 3D conditions (Mean ± SD).
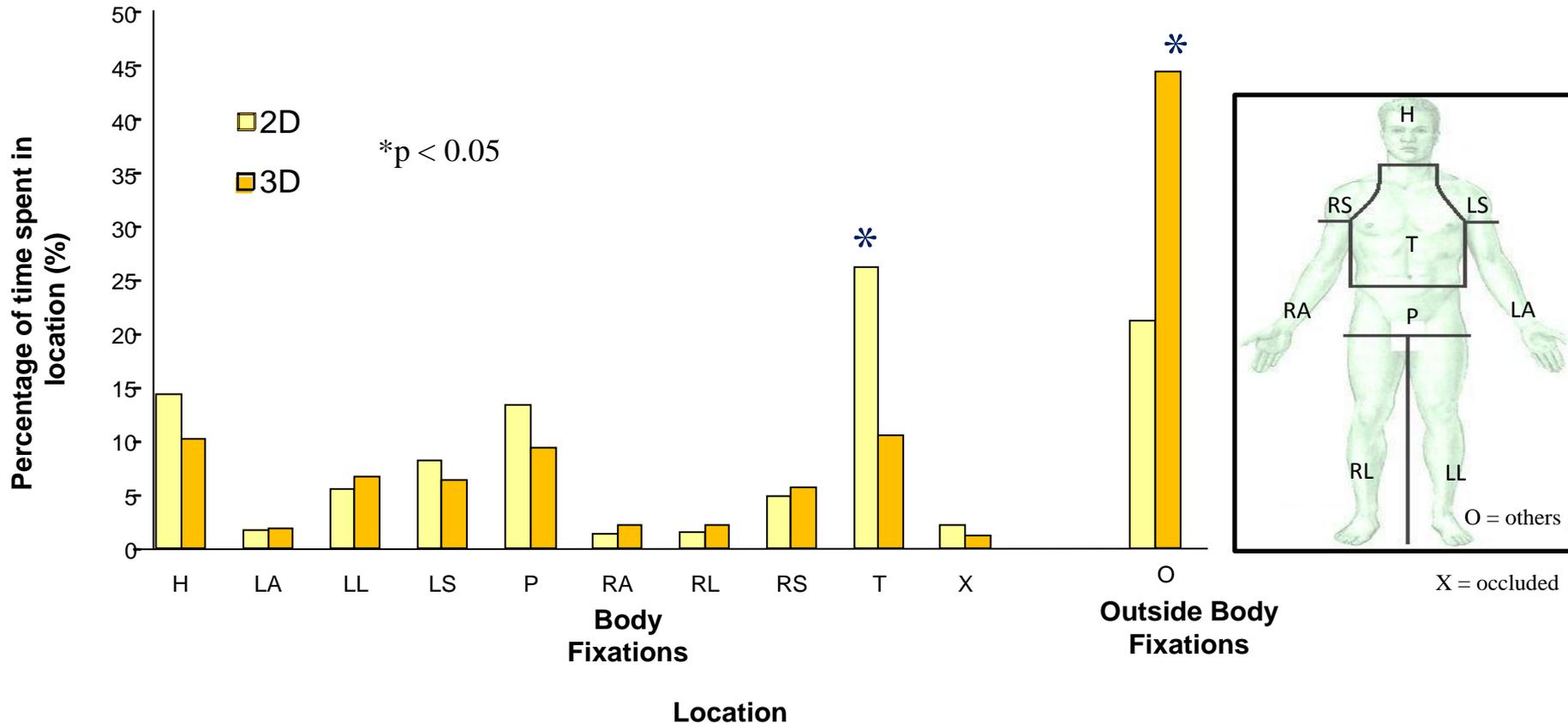
	2D	3D
Number of fixations	6.2 ± 1.1	6.5 ± 1.3
Fixation duration (ms)	332.7 ± 156.6	294.0 ± 119.6

No significant differences between 3D and 2D

Results: Gaze behaviour
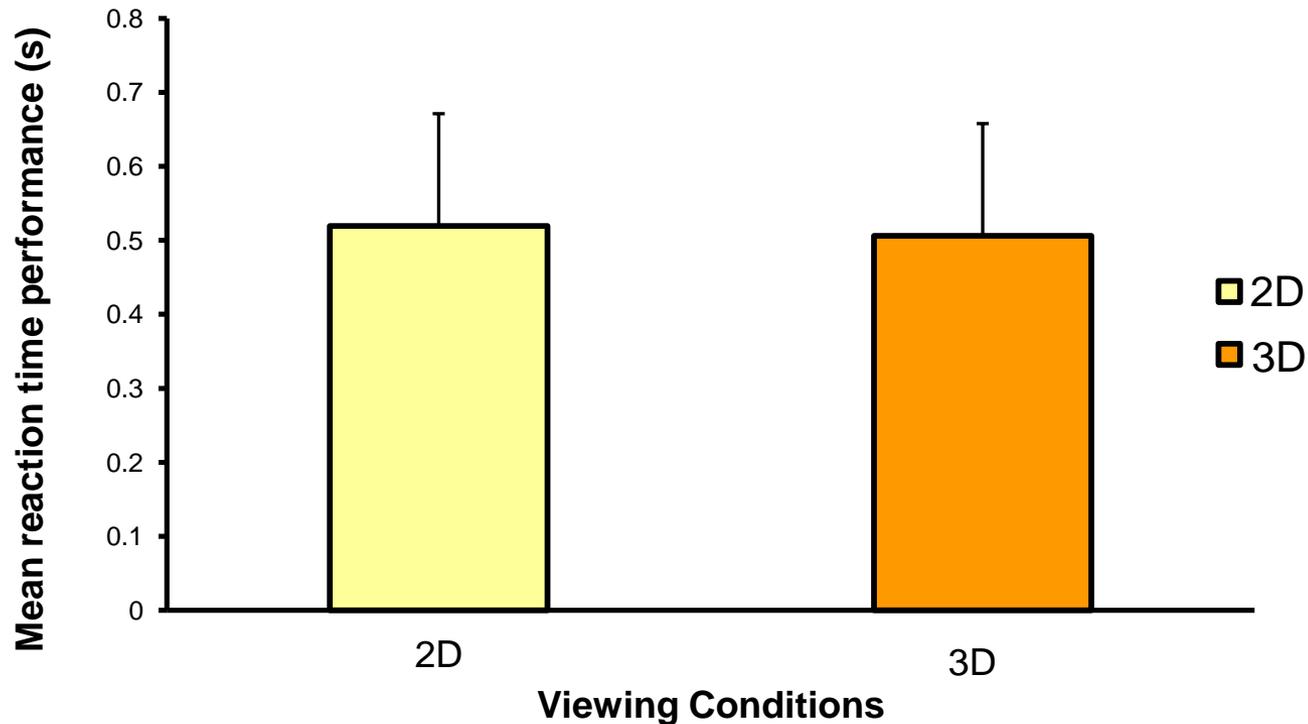
Lee et al., 2013 (Journal of Motor Behaviour)

➢ **Time spent fixating on locations**

2D → more fixations on the trunk (T)
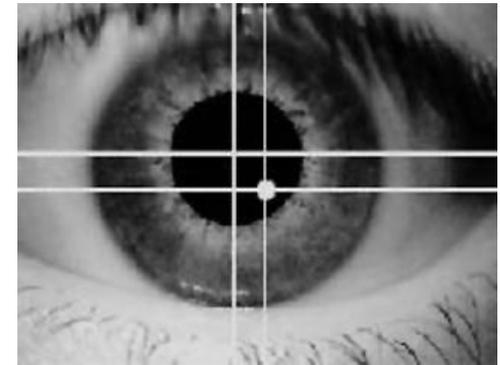
3D → more fixations on other (O)

No significant differences between 3D and 2D

Discussion

1. ⬆ **fixation time outside of the body in 3D :**

   – More distracting (Hakkinen et al., 2010)

   – Increased "presence" (Freeman et al., 1999)

2. ⬆ **fixation time outside of the body in 3D but no differences in reaction time:**

   – 3D more informative: Less fixations on body for same performance

Discussion

3. **If 3D afforded participants' earlier reading of opponent's movement, why didn't they react quicker?**

- One opponent visual stimulus too simple (Atchley et al., 1997)

- Task of standing interception too simple

- There is an optimum time-to-contact for an interception task

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Significance of study

Technological:

- Assess PERCEPTION - ACTION
- Bring game environment into the laboratory
  - conditions well-controlled
  - repeatable

Experimental:

- Highlights importance of stimulus and task complexity
- 2D or 3D? Consider nature of task

Current & future work

- Increase stimuli complexity (e.g. 1 to 2 opponents) & task complexity (e.g. running sidestep instead of standing)

- Compare sidestep responses elicited by different visual stimuli

- Establish perceptual-action link with skill level & non-contact ACL injury risk Lee et al. 2013 (in press; Medicine & Science in Sports & Exercise)

| Arrow-planned | 1-Defender Scenario (1DS) | 2-Defender Scenario (2DS) | Arrow-Unplanned (AUNP) |

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Current & future work

- Understand visual search and movement in 10-pin bowling during 5-step approach

- Develop "Quiet-eye" training (Vickers, 2007)

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Thank you