Predicting attention for performance & safety: the value of cross-field applications

Vienna, 13th of June 2022

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NEXTGEN TRAINING TECHNOLOGIES

DATA DRIVEN COMPETENCE-BASED TRAINING & ASSESSMENT

HUMAN ATTENTION PREDICTION PLATFORM

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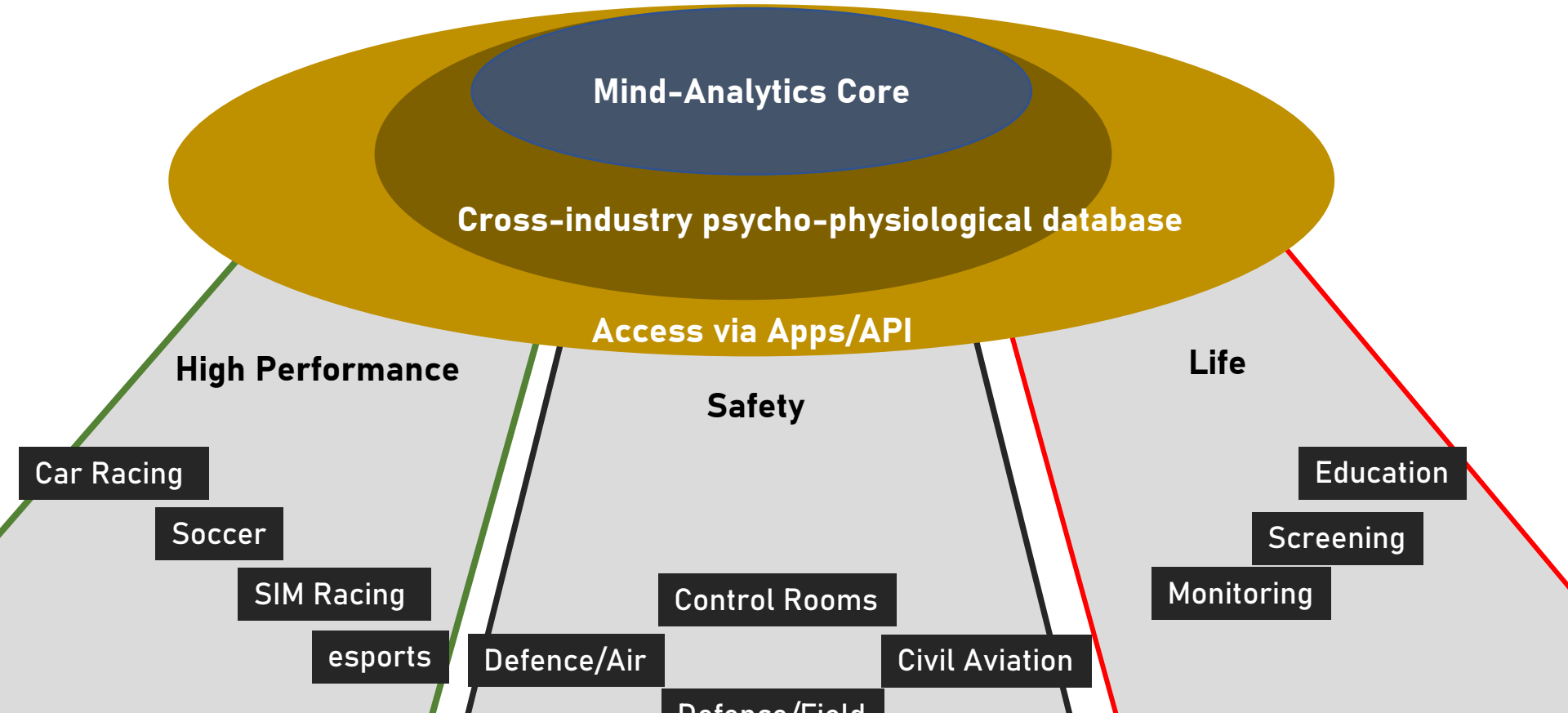
1. Applied R&D projects
2. Analytics-as-a-Service
3. Software-as-a-Service



By The Brainstorms Scientific LBF GmbH

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Sports

Aviation

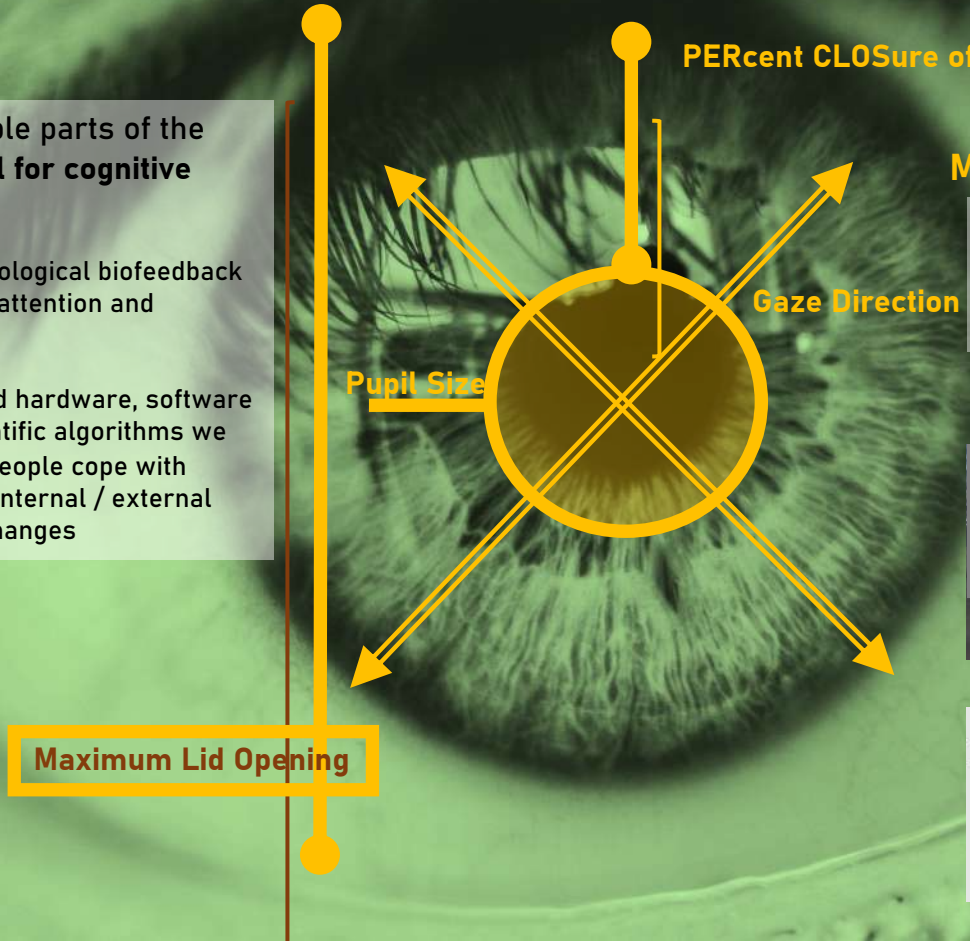
Medicine

NEXT-GENERATION BIOFEEDBACK FOR SAFETY AND PERFORMANCE

Biologically, as “visible parts of the brain“, **eyes are ideal for cognitive monitoring**

We analyze psychophysiological biofeedback to track changes in e.g., attention and perception

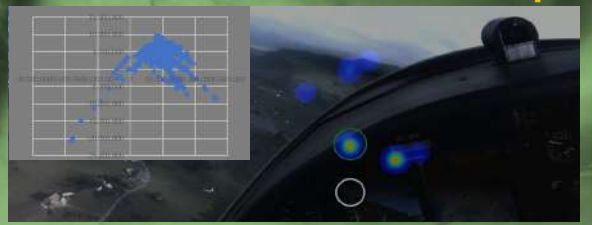
By combining specialized hardware, software and patented neuroscientific algorithms we get to understand how people cope with increasing mental load, internal / external stressors and sudden changes



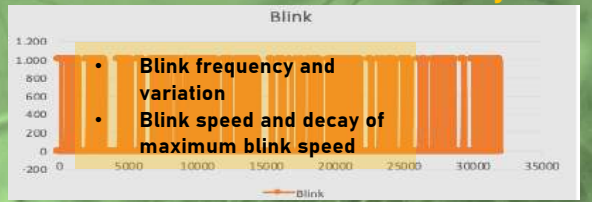
Multi-Parameter Cognitive Analytics

- PERCLOS index
- Gaze direction
- Scanning patterns
- Pupil diameter changes
- Fixations
- Saccades
- Patterns and configurations

Gaze Heatmaps



Blink Analytics



- Blink frequency and variation
- Blink speed and decay of maximum blink speed

ASSUMPTIONS

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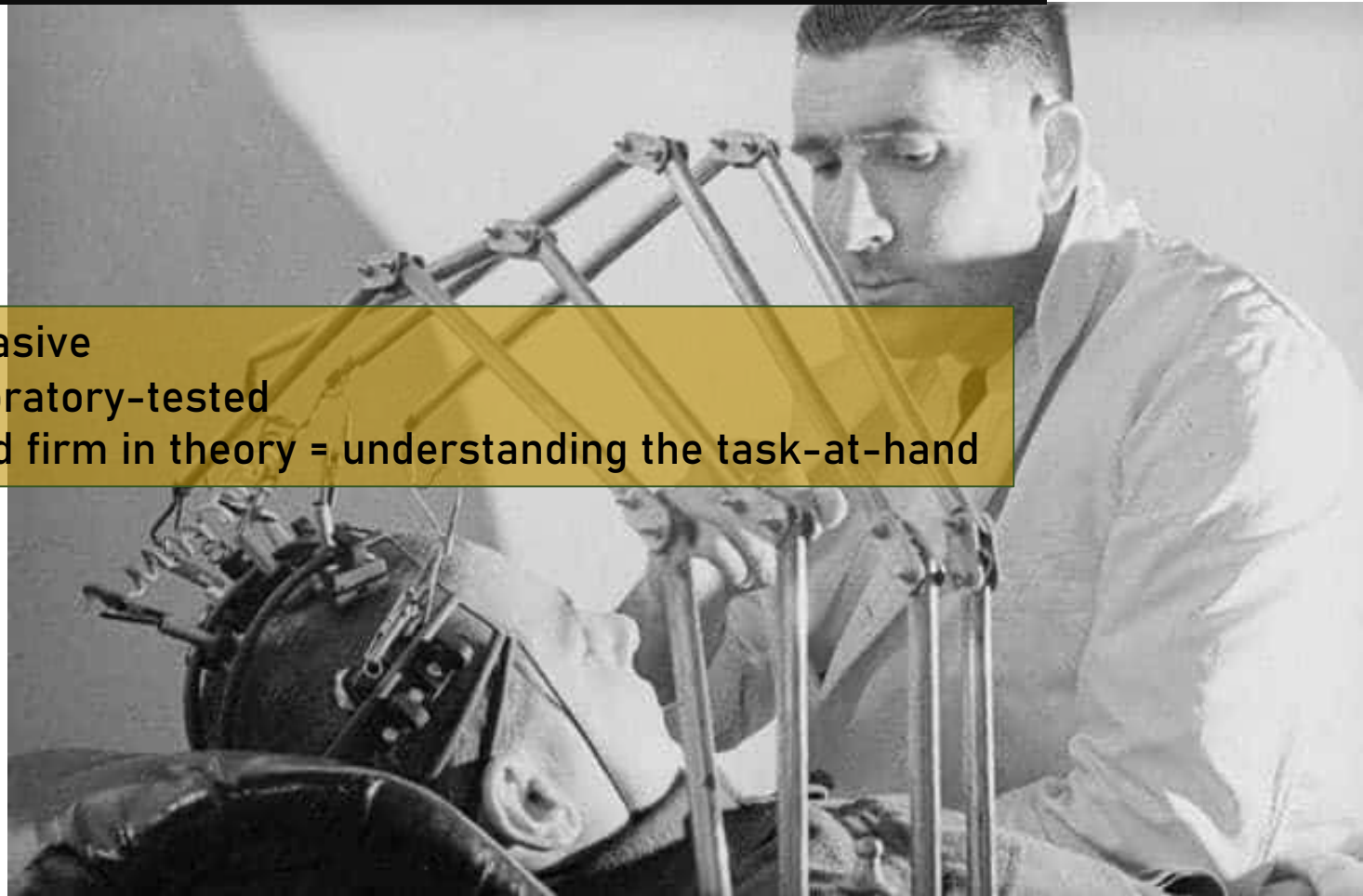
non-invasive > invasive
field-proven > laboratory-tested
knowledgeable and firm in theory = understanding the task-at-hand



ASSUMPTIONS

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- Our brains predict for maintaining the body's energetic system
- *We* are predicting how the "mind" of our trainees works, while it predicts
- (because predicting is what brains do)
- and while it creates/experiences emotions

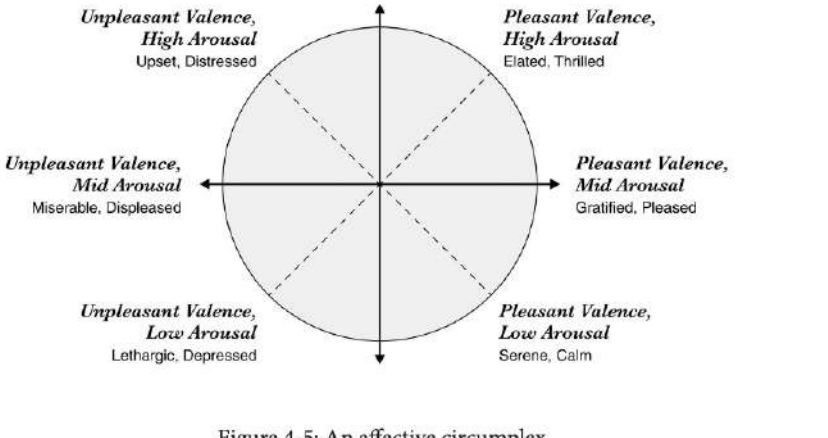

Figure 4-5: An affective circumplex

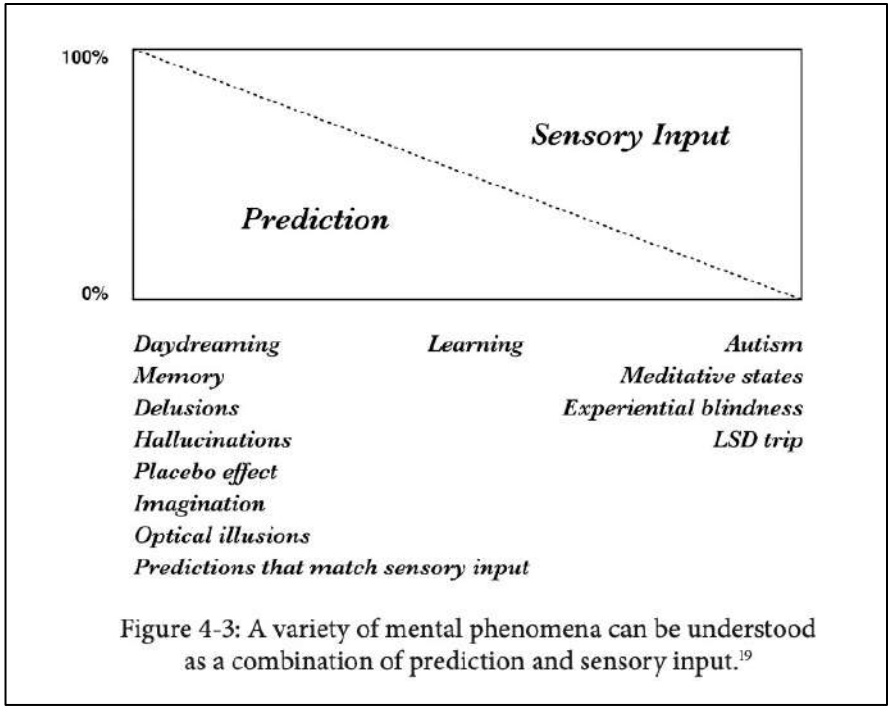

Figure 4-3: A variety of mental phenomena can be understood as a combination of prediction and sensory input.[19]

vgl. Hutchinson, J. B., & Barrett, L. F. (2019). The power of predictions: An emerging paradigm for psychological research. *Current directions in psychological science*, *28*(3), 280-291.
Barrett, L. F. (2019). How emotions are made.

BASICS: STATE RECOGNITION – FATE PREDICTION

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1. Measuring Bio-Signals and their variations

2. Converting psycho-physiological measures to information

3. Contextualizing behaviour by describing action and action-space, sufficiently

4. Synchronizing between event-driven task environment and process-based biology

5. Understanding the process (not the event only)

Psycho-physiology & Cognition

Psych. Forces impacting attention
- Emotions
- Motivations
- Activation (Sleep/Fatigue – Hyperarousal)

Psych. Functions of Attention
- Alerting
- Orienting
- Executive

PSYCHO-BEHAVIOURAL MODELS

Domain of Attention Allocation	Ψ/ϕ	Mode of Attention Allocation	
		Exogenous	Endogenous
	Space	x	(x)
	Time	x	(x)
	Sense	x	(x)
	Task	x	x

Volition & Behaviour

- **Definition of Task Environment (physical):** e.g., 3D-dull, dangerous, dirty?
- Definition of task demands, regardless thresholds for success
- Continuous Monitoring of behaviour, framed by the **task environment**
- Digital model of environment
- Digitalization or digital model of actions
- (Real-time inference to constructs behind actions for immediate feedback)

BENCHMARKS

Performance & Outcome

Capturing the nature of performance
- Definition of Key Performance Indicators (KPIs)
- Operationalizing these KPIs, many times finding a proxy
- Factoring in of "natural" and technical trade-offs
- Definitions of Decision making and Standard-Operating-Procedures (SOPs)

Capturing the components of performance
- **The Specificity of Performance**
- Fatigue monitoring
- Mental load – task saturation
- Task switching
- Situational Awareness, vigilance
- Capabilities, including personality
- Competence-base: skills/knowledge
- Psycho-physiological process
- Actionable insights

WORLD-CLASS HARDWARE PARTNERS

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Devices of our partners are being used in Defence, Aviation and Racing, among other industries

Smart Glasses
"View Point System – VPS 19"

Virtual Reality Tactical Training
System XTAL II/3 and 4

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“A genius! For 37 years I’ve practised fourteen hours a day, and now they call me a genius!“

Pablo Sarasate/Spanish violinist and composer

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Talent vs. Practice
Nature vs. Nurture

Why a “versus” after all when common sense presumes interaction?

RELATIONSHIPS ARE ...COMPLICATED

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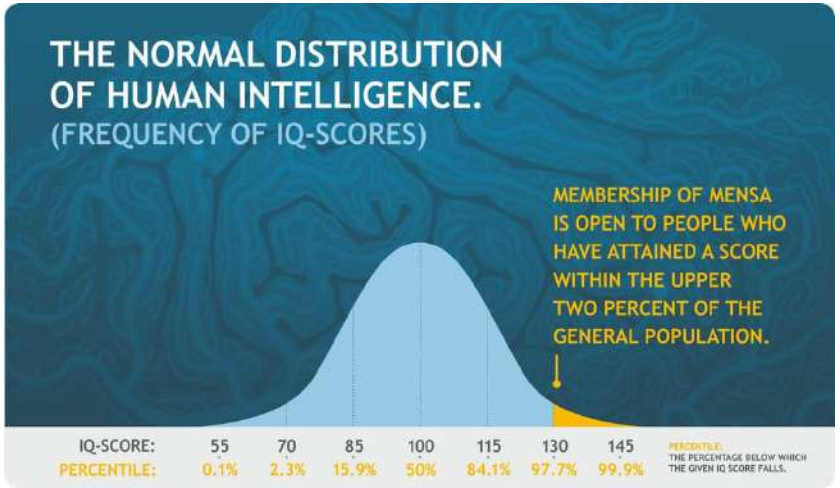

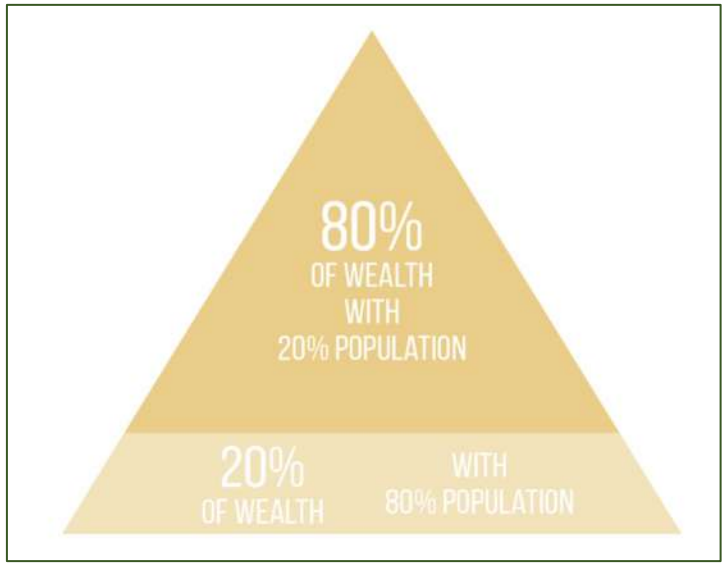

Features like “Intelligence“ are the INPUT

Key-Performance Indicators like “Wealth“ are the OUTPUT

THINGS THAT RELATE ARE ...PICKY

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Figure 3. Frequency distribution of individual performance

(O'Boyle and Aguinis, 2012)

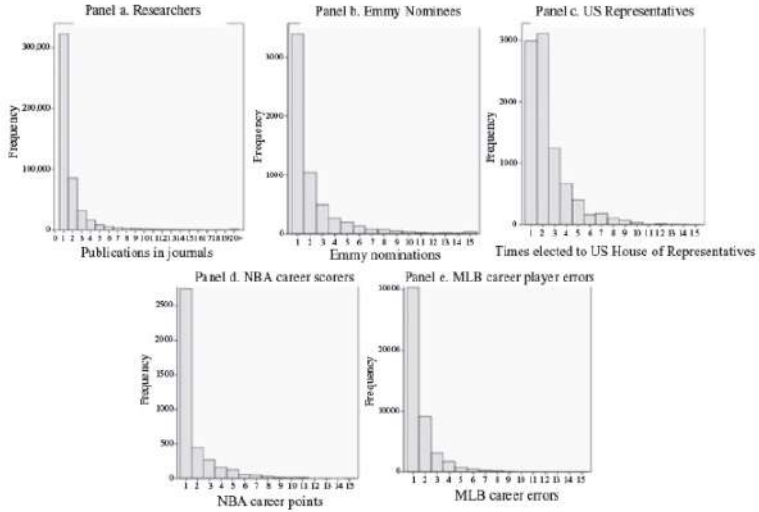

Figure 2: **Distribution of Individual Performance for Researchers ($N = 490{,}185$), Emmy Nominees ($N = 5{,}826$), United States Representatives ($N = 8{,}976$), NBA Career Scorers ($N = 3{,}932$), and Major League Baseball (MLB) Career Errors ($N = 45{,}885$).**

Note. For all Y axes, "Frequency" refers to number of individuals. For clarity, individuals with more than 20 publications (Panel a) and more than 15 Emmy nominations (Panel b) were included in the last bins. For panels c–e, participants were divided into 15 equally spaced bins.

TALENT DETECTION AS A GOAL

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BUFF-CAM for recognition and classification of Eye- and Lidmovements

(2020-2022)

A man imagining his buff self

“Strengthen
In gaming, a buff is an effect that strengthens an in-game character. For example, an ability that increases a character's hit points (HP) or attack power (AP) is a buff.
Typically, players use buffs on themselves and other player characters (PCs). For example, before a boss battle, a player might cast a buff spell that increases their party's attack speed and HP regeneration. In many games, enemies can also use buffs to strengthen themselves or other enemies. Many buff abilities are targeted, meaning they affect only one or more specific characters. However, some are area of effect (AoE) abilities, which affect any character who enters the effect's radius.”

Goal: Develop a method to detect Talents in e-Sport with devices monitoring psycho-physiological processes

Output: Set of methods for racing, SIM racing to detect talents and find ways to train them.

EFRE
Europäische Union Investitionen in Wachstum & Beschäftigung. Österreich.
BURGENLAND
DIESES PROJEKT WIRD VON BUND UND LAND BURGENLAND GEFÖRDERT.

REAL-LIFE REQUIREMENTS FROM SIMULATION

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Table 3. Demands of various pressure conditions in esports.

Pressure condition	Demands (examples)
Time	Execution of perception, decision, and action within limited time; fast reactions to visual, acoustic or haptic stimuli; synchronous and sequential actions
Precision	Accurate and precise movements of mouse, hitting the correct keys and buttons
Situation	Variability and complexity of situations in the game
Complexity	Simultaneous and/or sequential coordination of movements; number of hands, fingers, and movements to be coordinated
Stress and strain	Physical and psychic stress/strain regarding muscles (fingers, hand, arm) as well as cognition, perception, motivation, volition, and emotion

https://doi.org/10.1371/journal.pone.0237584.t003

Sensori-motor control:
Mouse & keyboard
Eye-hand/foot coordination
Spatial perception
Flexibility, strength & endurance
Balance
Reaction & anticipation
Rhythm
Motor and sport skills

Cognition:
Perception & attention
Understanding structures and meanings
Strategic thinking
Problem solving
Planning, management
Memory & knowledge

Emotions, motivation & volition:
Emotional control
Stress control
Causal attribution

Personal competencies:
Self-observation
Self-critics
Self-efficacy
Identity
Self-concept
"Big five"

Social competencies:
Cooperation
Interaction & communication
Mutual support
Empathy
Moral and ethical judgements

Media literacy:
Media knowledge
Self-regulated use
Active communication
Setup & customization
Maintenance
Trouble shooting
Media design

Fig 1. Competence model of digital games (according to [9] and [11]).

https://doi.org/10.1371/journal.pone.0237584.g001

BUFF-CAM for better Mindset Power and control of peak performance and stamina

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Thank you for your attention!

Cases

- Aviation
- Soccer

SOCCER: COGNITIVE PROCESSING INSIGHTS DERIVED FROM EYE ACTIVITY

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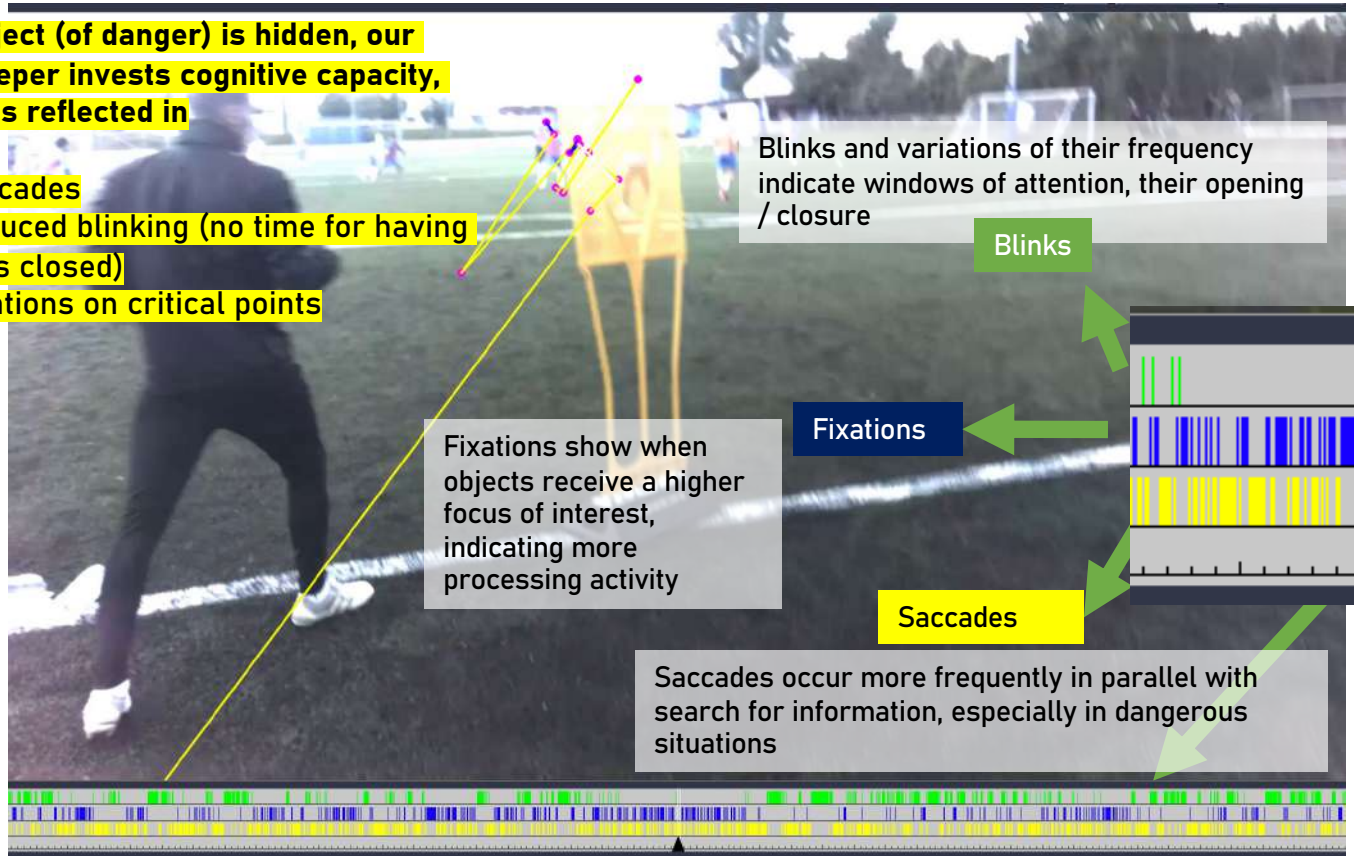
The object (of danger) is hidden, our goalkeeper invests cognitive capacity, which is reflected in

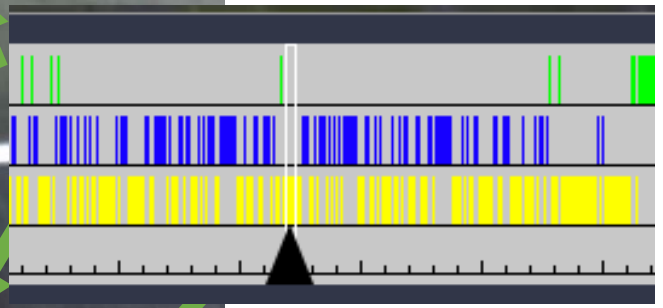
- Saccades
- Reduced blinking (no time for having eyes closed)
- Fixations on critical points



Blinks and variations of their frequency indicate windows of attention, their opening / closure

Blinks

Eye monitoring results

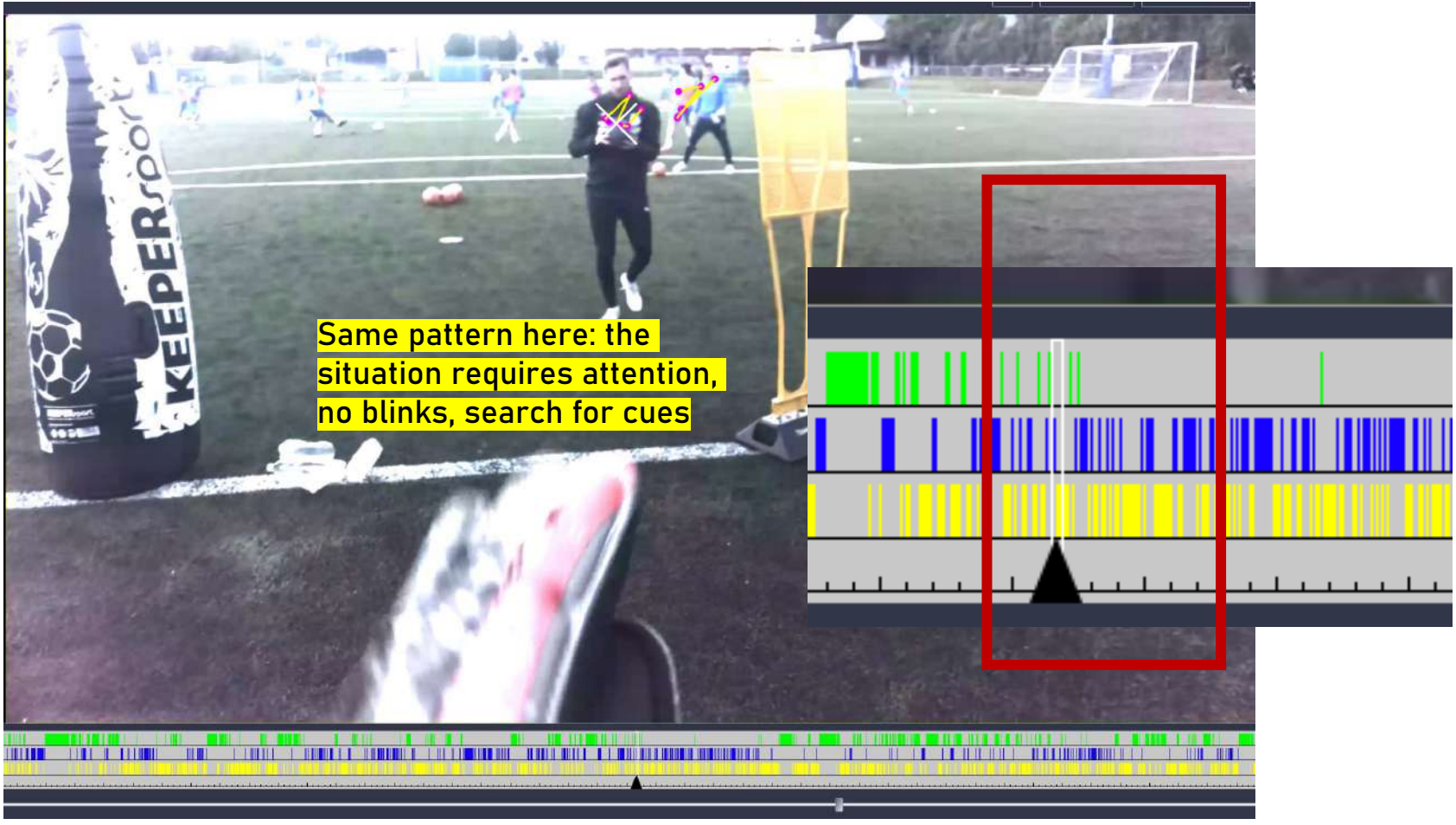


Fixations

Fixations show when objects receive a higher focus of interest, indicating more processing activity

Saccades

Saccades occur more frequently in parallel with search for information, especially in dangerous situations


KEEPERsport
Same pattern here: the situation requires attention, no blinks, search for cues

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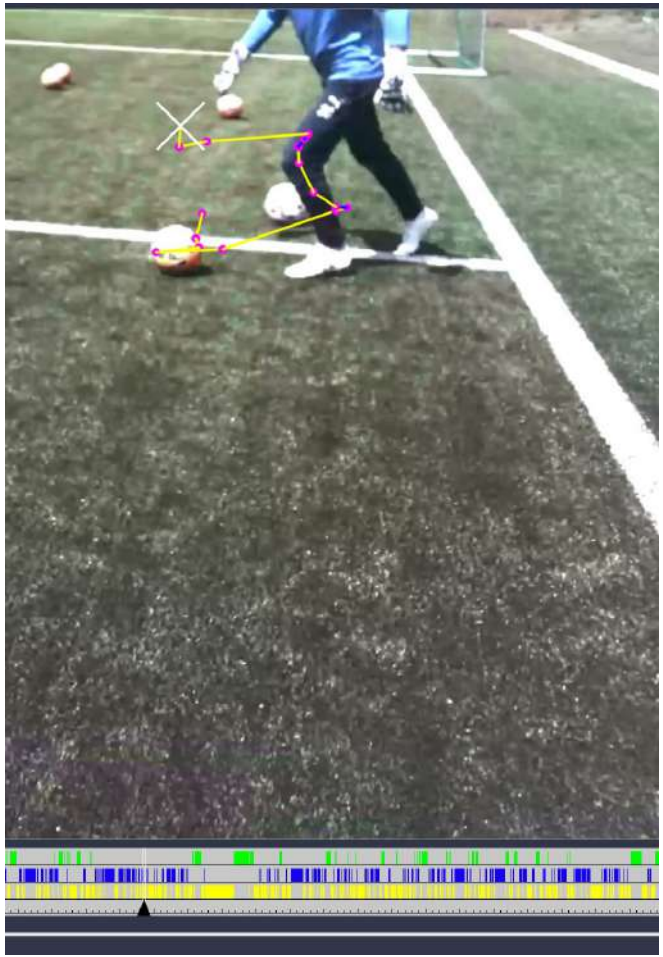
1.



2.

3.

Seconds later

FEASIBILITY STUDY AT SWISS FLYING CLUB

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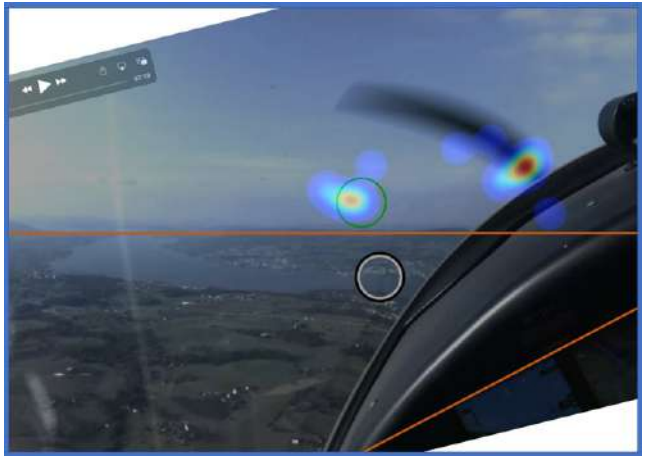

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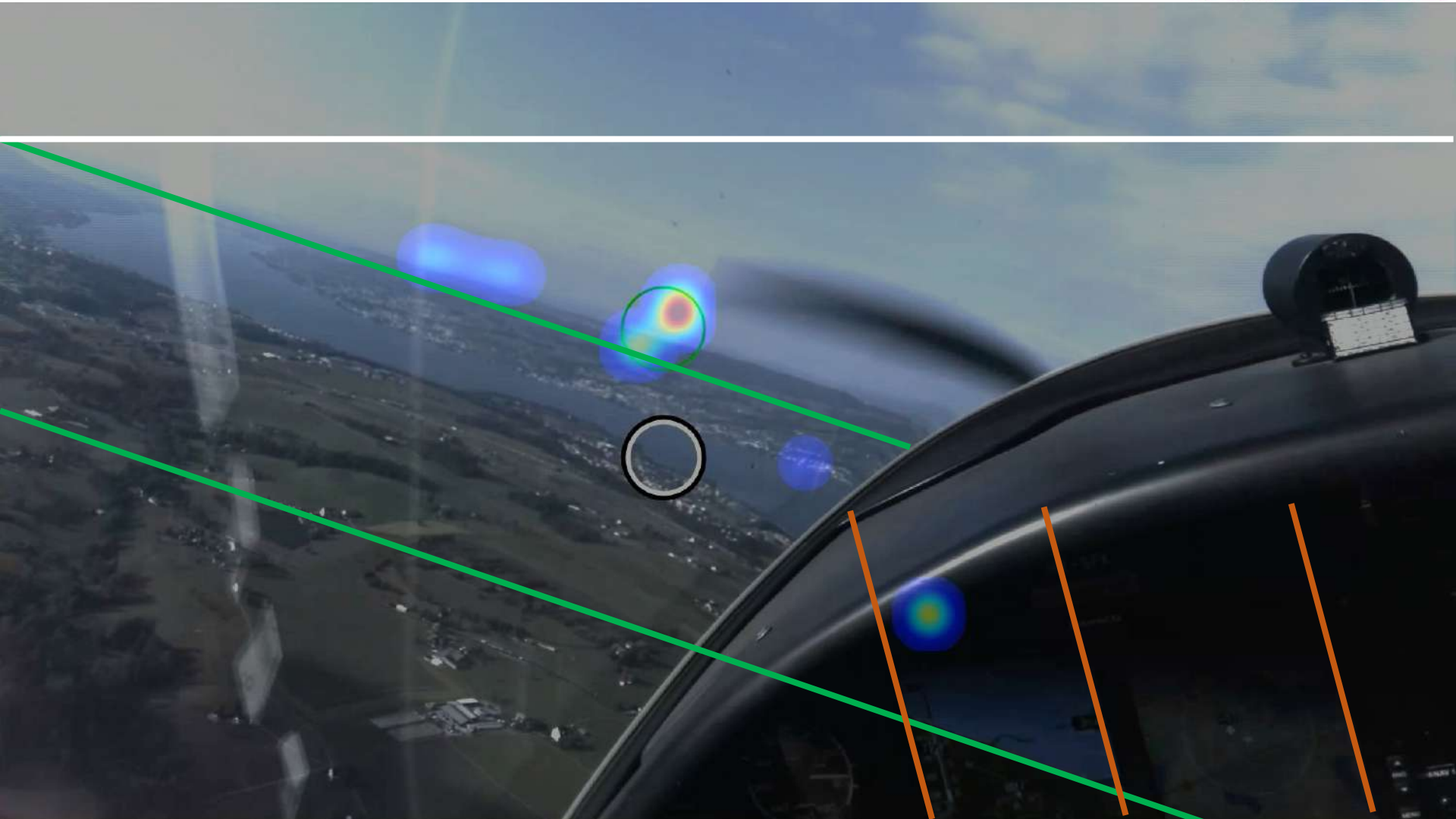
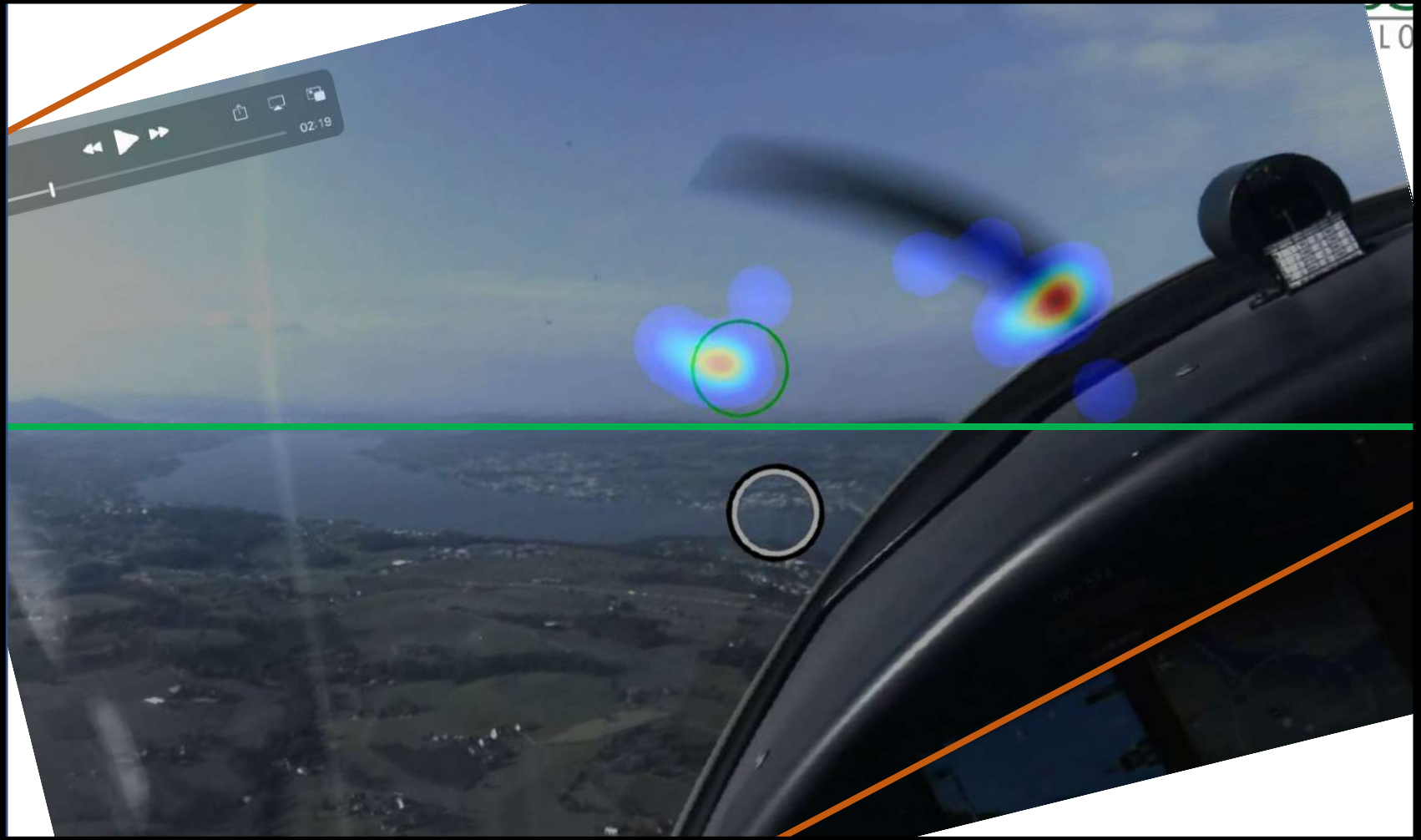
NO SMOKING

HB - SFX
GARMIN




02:19

NO NIGHT VFR
GARMIN